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INTRODUCTION

Violent fluctuations in price and international exchange rates cause significant shifts in the distribution of commodities and preclude a fair comparison of trends in trade when annual totals of value are used for such comparisons. For example, the reported value of United States imports of pig tin in 1932, amounting to $16,473,998, was 37 per cent of that in 1934, but in quantity the imports in 1932—34,819 long tons—were 87 per cent of those in 1934. The import statistical tables of this study, based on official customs reports of the countries involved, cannot in every instance be accepted as indicating countries of origin. Pig tin shipped from British Malaya to Hong Kong and the United Kingdom is frequently warehoused and exported at a later date to the United States or continental Europe; in such instances, Hong Kong and the United Kingdom are credited as the country of origin, although British Malaya is actually the source of the material. Again, although blister copper may have been shipped from Chile to the United States for refining and export, it will be found that the material when refined and exported appears in the United States official export statistics as "of domestic origin." In the official export trade returns of the United States and in the several official import customs returns of the countries of destination, Chile cannot be identified as the original source of the raw material, as the United States is reported to be the country of origin.

The international trade analysis in this report is based on figures for 1932 and 1934. The year 1932 is considered as representative of the lowest level of the world depression and therefore a datum point. By the end of 1934 a number of positive factors, some of an artificial nature, so affected international trade that an analysis of the trend and causes thereof over the 3-year period can justifiably be made.

Immediately after the industrial revolution in the last century, manufacturing centers were determined principally by ready access to raw materials and proximity to markets for manu-

factured products. At a later period the centers of manufacture were related more closely to the supply of power-generating fuels. Mineral raw materials, essential to the maintenance and growth of modern industries, are from a geographic viewpoint widely distributed throughout the world. No country is self-sufficient in its domestic supplies of such minerals. Even the United States must import certain mineral raw materials as well as export other mineral commodities of which it has an exportable surplus. World-wide trade in minerals, therefore, may be considered the very lifeblood of domestic industry, with respect to all countries that may be classified as industrial nations.

The study undertaken herein is not intended to cover mineral reserves or potential sources of mineral raw materials. Its purpose is primarily to indicate the present-day sources of supply and the interdependence of nations for the mineral raw materials required to maintain and further develop domestic industries. From a conservational point of view, it must be recognized that the raw material problem, as applied to minerals, cannot be compared with that concerning foodstuffs, for example. Oil, coal, copper, and iron are irreplaceable, and, therefore, while mineral production of all the countries in normal years may serve as an index of the mineral wealth and industrial prosperity of a given country, the fact that mineral resources are not replaceable is a qualifying factor necessarily considered in any forecast relative to the rank of this or another nation. Experience gained during the World War stresses the advantage of an adequate supply of raw materials easily available for immediate consumption. The action taken by certain countries in the last few years, manifested in the form of export restrictions, import licenses, quotas for industrial use, and international agreements designed to stimulate the export of manufactured products and thereby permit increased imports of raw materials, also emphasizes the strategic importance of mineral raw materials.

The charts used in the study have been selected merely to present the salient facts relative to world production, major exporters, and principal importers of the 32 minerals covered by the study.

No adequate data are available for stocks in warehouse, private or government, or material in process. In a study of mineral economics, consumption cannot be separated from mineral production. Therefore the only practical method of determining approximate consumption of a given commodity by any country is to add domestic production to imports and deduct exports therefrom. However, in recent years many countries have established stocks of strategic mineral raw materials and by governmental decree have forced industrial use of scrap and substitute metals. Because of this, no effort has been made in this study to indicate in tabular form apparent consumption of the materials involved. But in the series of charts covering the 32 minerals, in the preparation of which official statistics were used, apparent consumption for 1934 is indicated.

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PART I

SURVEY BY MINERALS

FOREWORD

Each mineral is considered separately to indicate the relative position of the principal world sources of supply with respect to the 32 minerals and likewise to show the extent of dependence on international trade of the 12 major industrial countries covered by the survey.

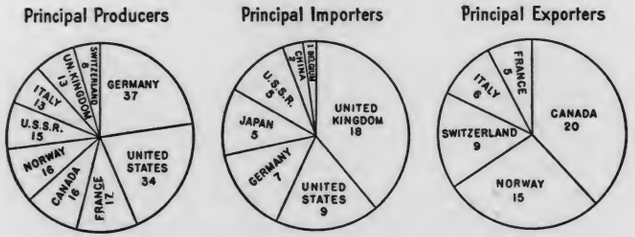
Throughout this report emphasis is placed on the status of the major industrial nations as producers and importers or consumers of the designated mineral raw materials. It must be recognized, however, that several countries not referred to in detail are outstanding producers of certain essential minerals that may be termed *deficient raw materials* as applied to major consumer nations—for example, antimony and tungsten of China, manganese of Gold Coast and British India, nickel and chrome of New Caledonia, tin of British Malaya, Netherland India, and Bolivia, and vanadium of Peru. Consequently, although the capacity of the world or of a group of countries to consume may be the determinant in normal world trade or movement of mineral raw materials, nevertheless countries that are leaders in the production of deficient strategic raw materials hold key positions, and their allegiance or proximity to one or another of the major powers is a factor that can never be overlooked.

The commodity survey (Part I) has been restricted to consideration of crude raw materials only. An effort has been made to consider the ores and intermediate products up to and including the smelter products.

In Part II, import trade statistics have been compiled for certain fabricates, alloys, and scrap and secondary metals. The influence of these materials upon the international trade of primary shapes becomes more significant every year.

ALUMINUM – 1934

(all figures in thousands of metric tons)



By far the largest part of the aluminum produced throughout the world is derived from bauxite ore, but a small quantity is obtained from such materials as leucite, alunite, and nepheline. Bauxite is a hydrated oxide of aluminum, or a mixture composed of at least two and in some instances three hydrates, containing various impurities, chiefly iron oxide, silica, clay, and titanium oxide. Crude bauxite is treated with acid to remove these impurities, and the residual matter then calcined. The resultant product is the material used as the source of alumina and aluminum. Some years ago the manufacturers of aluminum formed a cartel which determines the export quotas and the price of aluminum but permits free competition in the fabricates. The United States is not a member of this cartel.

WORLD PRODUCTION

United States.—In the United States, alumina is derived from the bauxites of Arkansas and of Surinam (Dutch Guiana). The ore is reduced to alumina at East St. Louis, Ill., and is shipped to Niagara Falls and Massena, N.Y.; Alcoa near Knoxville, Tenn.; and Badin, N. C. Practically all of the goods fabricated from aluminum consumed in the United States are of domestic manufacture. A small part of the additional alumina necessary to meet market demands is imported from Canada; the balance is of domestic origin.

Germany.—Germany is now the leading world producer and fabricator of aluminum and aluminum goods. The great increase in German manufacture and consumption began early in May 1934, after the decree of the Control Office regulating the use of base metals. Germany's deposits of bauxite are not large enough to justify mining; therefore the tonnages required for the manufacture of aluminum are imported from Yugoslavia, Hungary, and France. Scrap and crude aluminum is imported largely from Norway and Sweden. The German alumina plants are at Lauta and Duisburg, and the aluminum reduction plants at Rheinfelden and Grevenbroich, where electricity is obtained from falls in the Rhine; there is also a plant at Innwerk in Bavaria, where power is obtained from streams of the Upper Danube Basin. Power is generated from the utilization as fuel of lignite obtained from the central German deposits.

Canada.—There are no known commercial deposits of bauxite in Canada. The Aluminium, Ltd., has a plant at Shawinigan Falls, Quebec, where hydroelectric power is generated and alumina imported from the United States is reduced to the metal. The larger part of the output is in the form of ingots, which are shipped to the United States for fabrication. The balance is fabricated at the plant. The Aluminium, Ltd., also has a plant at Arvida on the Saguenay River, Quebec, which uses hydroelectric power and reduces to aluminum the bauxite imported from British Guiana. The plant capacity is said to be 125,000 tons a year.

Norway.—The topography of the coastal area of Norway permits the generation of hydroelectric power adjacent to the sea, enabling Norway to develop and produce electric power at a very low cost compared with that of hydroelectric plants in other countries. As Norway has no bauxite deposits, alumina and bauxite are imported for reduction, and the aluminum is exported in the form of ingots. The total rated capacity of the six plants is about 36,000 tons per year. The Norwegian plants are largely controlled by foreign capital.

France.—There are large deposits of bauxite in France on the east side of the Rhone Valley near the Italian and Swiss boundaries. The aluminum industry is contiguous to the mines and utilizes hydroelectric power. The two largest companies operating in France have a common sales agency known as the Alu-

minum Française. This company also fabricates aluminum. On Apr. 16, 1935, the exports of bauxite, alumina, and aluminum were placed under the jurisdiction of the Minister of Finance by a decree.

Italy.—The development of hydroelectric power in Italy has made possible the production of aluminum from native bauxite ores mined in the District of Istria. The rated annual capacity of the aluminum plants is 36,000 tons of alumina and 15,000 tons of aluminum. Plans are under way to expand this capacity substantially. The alumina plants are at Bussi and Porto Marghera and the aluminum plants at Borgofranco, Bussi, Mori, and Porto Marghera. A considerable part of the Italian aluminum industry is operated by foreign capital. Recently an effort has been made to place Italian capital and management in more effective control of the industry.

United Kingdom.—There are no bauxite deposits in the United Kingdom, but imported ore is converted into alumina at plants in Ireland, Scotland, and England. There are aluminum reduction works in Scotland near the sea and in a region where large hydroelectric projects have been installed. A small reduction plant operates in North Wales.

Switzerland.—This country has no deposits of bauxite but does have abundant power resources developed from the Alpine streams. Two companies operate plants at Neuhausen, Chippis, and Martigny-Bourg and import alumina for reduction to the metal.

U.S.S.R. (Russia).—Bauxite deposits occur at Tikhvin, Russia. The development of the aluminum industry of Russia has been rapid. The first alumina and aluminum plant was constructed at Svanka near Volkhov in northwestern Russia. Water power generated by the Dneper River is utilized at the Zaporoges plant in the Ukraine, which was completed in May 1935. At Kamensk a plant is being erected to treat the yet undeveloped bauxite deposits of the Urals. The Kola Peninsula contains deposits of nepheline, which are to be mined and converted into alumina at Kandalaksha; the product will be shipped to a plant on the White Sea-Baltic Canal, where it will be reduced to aluminum.

Under the Second Five-year Plan, which ends in 1937, the estimated production capacity of the projects under construction

or in operation is 185,000 tons of alumina and 83,000 tons of aluminum, according to published reports of the Soviet.

Austria.—There are two aluminum plants in Austria, one at Lend in Salzburg and the other at Hallstätter See in Upper Austria.

Spain.—There is an aluminum plant at Sabinanigo, Huesca Province, Spain. Alumina is imported from France for reduction purposes.

Hungary.—There are large deposits of bauxite in Hungary. In 1935 a new aluminum plant was opened in Budapest. Immediately after operation was begun an import duty was levied on aluminum and aluminum alloys.

Yugoslavia.—There are extensive deposits of high-grade bauxite on the Dalmatian Coast, Hercegovina, and Montenegro, Yugoslavia. Recently a 15-year concession was granted for the manufacture of aluminum and aluminum alloys. Only Yugoslav subjects may hold shares or obtain permanent employment in the company.

Japan.—There are no bauxite deposits in Japan. Every effort is being made to produce alumina from home substitutes and from imports of bauxite brought in from the mandated islands of the southern Pacific and from Netherland India. Several firms have been experimenting with the production of aluminum, which was finally placed on a commercial basis in 1935. It is reported that the Japanese expect to have a plant capacity of 25,000 metric tons by the end of 1936.

Other Countries.—Recent advices report that the establishment of an aluminum industry is being considered in Czechoslovakia, Greece, and the Netherlands. Greece, being mountainous, could use water power to generate electricity for the conversion of alumina to aluminum from her own bauxite deposits. The Netherlands has large deposits of bauxite in Surinam (Dutch Guiana) and extensive supplies of coal, which could be used to generate power for the manufacture of aluminum.

INDUSTRIAL USES

The utilization of aluminum in the industrial world is of comparatively recent origin; the first article manufactured from aluminum was produced in 1855. Unlike many metals, its

introduction in the market was based mainly upon its physical and chemical properties. The most significant commercial characteristics are its lightness, conductivity, machinability, ductility, noncorrodibility, color, and nontoxic qualities. It is also applicable to wearing and bearing uses and to soldering and welding. By far the most important properties are lightness and conductivity; the weight of aluminum is only about one-third that of other common metals. Weight for weight, sheets of aluminum of equal thickness with sheets of other common metals have about three times the area. Thus the adoption of aluminum at even higher prices than other metals is based largely upon the economies effected by the saving of weight.

Although the conductivity of aluminum is only about 60 per cent that of copper, the difference in weight makes aluminum wire a competitor of copper for carrying electrical current. From a commercial standpoint, these two metals are interchangeable for the transmission of electricity. Aluminum is used extensively in certain industrial countries, such as Germany and Italy, which have insufficient reserves of copper to meet their industrial requirements.

The greater part of the aluminum consumed is utilized in the industries dealing with transportation. The adoption of lightweight streamlined trains by the railroads has increased the potential outlets for this metal. It is now used in large quantities in passenger-car construction and also for certain types of freight cars, such as tank and hopper cars. The selection of aluminum for tank cars has increased because of its ability to resist the corrosive action of the materials being transported rather than because of its lightness; the converse is true with regard to hopper cars, where lightness is required. Builders of trucks and bus bodies use aluminum to strengthen members in the body frame. In 1930 a new piston alloy with a low expansion coefficient was introduced; it has been reported that more than 75 per cent of the automobile passenger cars manufactured in the United States are using aluminum-alloy pistons. During the past few years, aluminum alloys have been employed in the manufacture of various structural shapes, which are now available on the market in sizes up to 85 ft. in length and 14 in. in depth. These are used by railroads, in railway-car construction, and for trucks and busses.

Most of the airplanes now manufactured are of metal, aluminum alloys being employed almost to the exclusion of all other metals.

Aluminum and its alloys find many uses in ship construction. Because of the many marine disasters in the past few years involving fire, there has been a greater demand for fireproof construction, and partition bulkheads are now being manufactured from these alloys.

During the past 5 years, owing possibly to the price ratio between copper and aluminum, the use of the latter metal in cables for high-power transmission lines has increased greatly.

Notwithstanding the keen competition in the market for culinary articles, the use of aluminum has increased. The price at which the articles can be sold, together with their nontoxic qualities, makes it apparent that aluminum will continue to hold its place in this field.

In heavy construction equipment, aluminum has enabled the manufacturer to increase the size and capacity of his product. For example, shovel dippers with a capacity of 32 cu. yd. are now manufactured from aluminum alloys; dragline booms over 250 ft. in length are also on the market.

In the metallurgy of iron and steel, the market for aluminum is ever-increasing. An appreciable tonnage of secondary aluminum is used in the open-hearth process as a deoxidizer in the manufacture of steel. In building construction, the metal is employed for roofing and sheet-metal material and also for such uses as spandrels, window frames, sills, grills, balustrades, and other ornamental appliances. The manufacture of such office equipment as desks, chairs, and file cases from the bright, light metals has increased greatly during the past 5 years.

Aluminum is also used as a paint and is finding an ever-expanding market as a covering for iron and steel exposed to weathering.

The industrial chemicals used include aluminum chloride, acetate, oleate, and stearate; in the conversion of ethyl alcohol to ethylene and in other organic reactions, bauxite and aluminum are used as catalysts.

In war material, aluminum has many diversified uses. When consideration is given to the increase in motor transportation and the part played by aluminum in the manufacture of trucks,

automobiles, and aircraft, the importance of this metal from a standpoint of military preparedness is obvious.

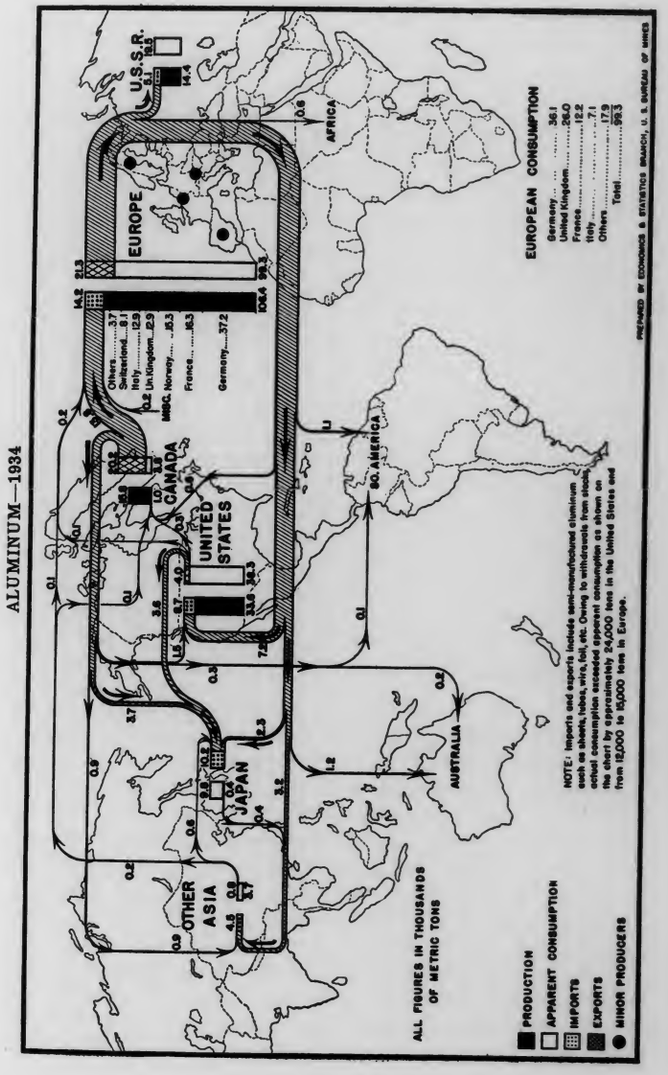
SUBSTITUTES

On the basis of price, aluminum or copper may be used interchangeably for high-voltage transmission lines. The enormous increase in consumptive demands in Germany illustrates the extent of the substitution of aluminum for other metals. Germany has made it mandatory that aluminum be used for high-voltage transmission lines to decrease the imports of copper and thereby assist in the stabilization of exchange.

WORLD PRODUCTION OF ALUMINUM, 1932–1934
(In Metric Tons)

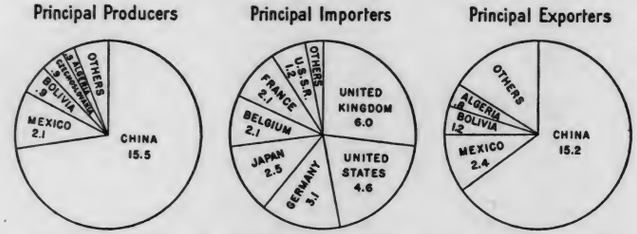
Country	1932	1933	1934
Austria	2,100	2,000	2,100
Belgium	.....	.....	100
Canada	17,800	16,200	15,800
France	14,400	14,500	16,300
Germany	19,300	18,900	37,200
Italy	13,400	12,100	12,900
Norway	17,800	15,400	15,300
Spain	1,200	1,200	1,200
Sweden	.....	.....	300[1]
Switzerland	8,500	7,500	8,100
U.S.S.R. (Russia)	1,000	4,400	14,400
United Kingdom	10,200	11,000	12,900
United States	47,600	38,600	33,600
Total	153,300	141,800	170,200

[1] May include production of minor producing countries of Europe.


ALUMINUM—1934
U.S.S.R.
EUROPE
AFRICA
CANADA
UNITED STATES
SO. AMERICA
JAPAN
OTHER ASIA
AUSTRALIA
EUROPEAN CONSUMPTION
Germany 36.1
United Kingdom 26.0
France 12.2
Italy 7.1
Others 17.9
Total 99.3
PREPARED BY ECONOMICS & STATISTICS BRANCH, U. S. BUREAU OF MINES
NOTE: Imports and exports include semi-manufactured aluminum such as sheets, tubes, wire, foil, etc. Owing to withdrawals from stocks, actual consumption exceeded apparent consumption as shown on the chart by approximately 24,000 tons in the United States and from 12,000 to 15,000 tons in Europe.
ALL FIGURES IN THOUSANDS OF METRIC TONS
PRODUCTION
APPARENT CONSUMPTION
IMPORTS
EXPORTS
MINOR PRODUCERS

ANTIMONY — 1934

(In terms of Metal)
(all figures in thousands of metric tons)



Stibnite (Sb_2S_3), a sulphide ore, is the most important source of antimony. Oxides and hydroxides occur at the surface and have been mined in Algeria; Sonora, Mexico; and Tuscany, Italy. In general, antimony ores are associated with volcanic activity and were deposited near the surface, although variations from this rule are noted. The deposits are only rich near the surface, the mines being only a few hundred feet deep at most. Stibnite is associated with quartz, calcite, sulphides of the base metals, arsenic, gold, and silver.

PRINCIPAL DEPOSITS

China.—Antimony ore occurs in several provinces in China, but 90 to 95 per cent of the output comes from the Province of Hunan, near Changsha, about 1,200 miles up the Yang-tze Kiang. The ore is smelted near the mines. Production began early in the twentieth century. Other deposits of antimony are found in Yunnan. In 1933 the Hunan Antimony Syndicate was formed to control the production and the export price of Hunan antimony.

Mexico.—A series of small antimony deposits extends from the states of Sonora, Chihuahua, and Coahuila on the north to Guerrero and Oaxaca on the south. Mining was begun in Mexico in 1898 and smelting a few years later. Late in 1930 a new antimony smelter of the Texas Mining & Smelting Co. began operations at Laredo, Tex., and eventually caused the closing of the

Mexican smelter. Antimony is produced in the states of San Luis Potosí, Querétaro, and Sonora.

Bolivia.—In the same general regions that bear the tin ores of Bolivia, chiefly in the southern part of the Department of Potosí, antimony-bearing veins occur in Paleozoic shales. The antimony was mined during the World War by the natives. The decline in antimony production of Bolivia is believed to have been due to the increased production in Mexico.

Czechoslovakia.—The antimony deposits of Czechoslovakia are in the eastern part, in the Erz Gebirge. The principal deposits are those of Spiska Bana (the largest producer) and Tschutschma, where the stibnite is associated with copper and gold. The concentrates are smelted in Vajskowa; deposits of antimony occur there but are no longer mined.

France.—The principal antimony deposits of France are in the Department of Mayenne, although there are other deposits in the Cantal district (Haute-Loire) of the Central Plateau.

United States.—Some antimony ore was produced in Idaho, but the United States has no antimony deposits, as such, which are regularly and profitably mined under ordinary conditions. Some deposits lack value because of the presence of arsenic and lead- or zinc-bearing minerals.

Italy.—The Italian deposits of antimony are in Sardinia.

Algeria.—The antimony deposits of Algeria are in veins of limestone in the Province of Constantine about 20 miles west of Guelma.

Other Countries.—Minor producers of antimony include Spanish Morocco, Greece, New South Wales, Japan, Peru, and Turkey.

INDUSTRIAL USES

Of the diversified industrial uses of antimony, a comparative few represent the larger part of the world's antimony requirements. The maintenance of a supply of antimony is extremely important to industrial nations. Were a manufacturing nation deprived of its requirements, the substitution of other metals for the needs supplied by antimony could be made only by the use of higher-priced material. If this situation should arise, it would be expected to place this nation at a disadvantage in a highly competitive international market.

As metal, unalloyed, antimony has no essential uses. Small quantities are required to meet the demands for certain pigments. When mixed with other metals, the alloys thus formed serve many needful purposes. The largest tonnage consumed in any single use is in the manufacture of battery grids. These plates are a component part of the storage batteries used so extensively in the automobile industry. For this need, antimonial lead, having an average content of 7 per cent antimony, is manufactured. Bismuth may be used as a substitute for antimony in battery grids, but the average price of antimony is about 11 cents a pound whereas bismuth sells for approximately 95 cents.

Babbitt and bearing metals are the next largest consuming use. Some of these alloys contain no antimony, while others contain as much as 20 per cent. Genuine babbitt consists of 80 per cent tin, 3.5 per cent copper, and 7.5 per cent antimony. In babbitt and antifriction metals, the antimony content ranges from 0.5 to 18 per cent. The important part played by these alloys industrially can be realized when thought is given to their wide use in our modern methods of transportation and also to the fact that up to the present no satisfactory substitute has been found for babbitt in the journals required in heavy-duty machinery.

Enamels, chemicals, and paints comprise the third largest field of use at present. The amount of antimony consumed in these uses is large compared to total uses, but this metal is not an actual necessity, from an industrial standpoint, as there are a number of well-known substitutes. For example, the oxides of antimony and tin are used in making white enamel. That made from antimony has a yellowish tinge, whereas that made from tin is almost pure white. In pigments, antimony oxide compares favorably in part only with such well-known pigments as lithopone and titanox. In chemicals, the principal use is in tartar emetic, where antimony appears as the trioxide. Tartar emetic is also used in fixing tannin. Several chemicals may be substituted for these uses.

Type metal is the next largest field of use for antimony. For an alloy to be suitable as a type metal, it must be easy to cast, fill the molds sharply, and at the same time be as hard as possible. No alloy completely satisfies these demands; lead and antimony best fill the requirements. Antimony hardens the

lead and greatly reduces the shrinkage that takes place in the cooling of lead, thus making it possible for the printer to have a die that will give a clear-cut impression. The antimony content of standard type metals ranges from 4 to 18 per cent. As the printing industry depends largely on this alloy, the importance of type metal is self-evident.

A minor consuming use, but one of commercial importance, is in cable sheathings. Lead is the principal component part of the alloy employed for this purpose. The amount of antimony contained is rarely less than 0.75 per cent and rarely more than 1 per cent. Pure lead could be used, but owing to its softness would be so easily damaged that antimony is regarded as a necessity.

In military emergencies the world's consumption of antimony is greatly augmented by the increased demand for motor transportation; moreover, this metal is considered a necessity for the manufacture of shrapnel.

SUBSTITUTES

Barium, calcium, cadmium, and lead alloys can be used as substitutes for antimony as a bearing metal, as well as in small-arms ammunition.

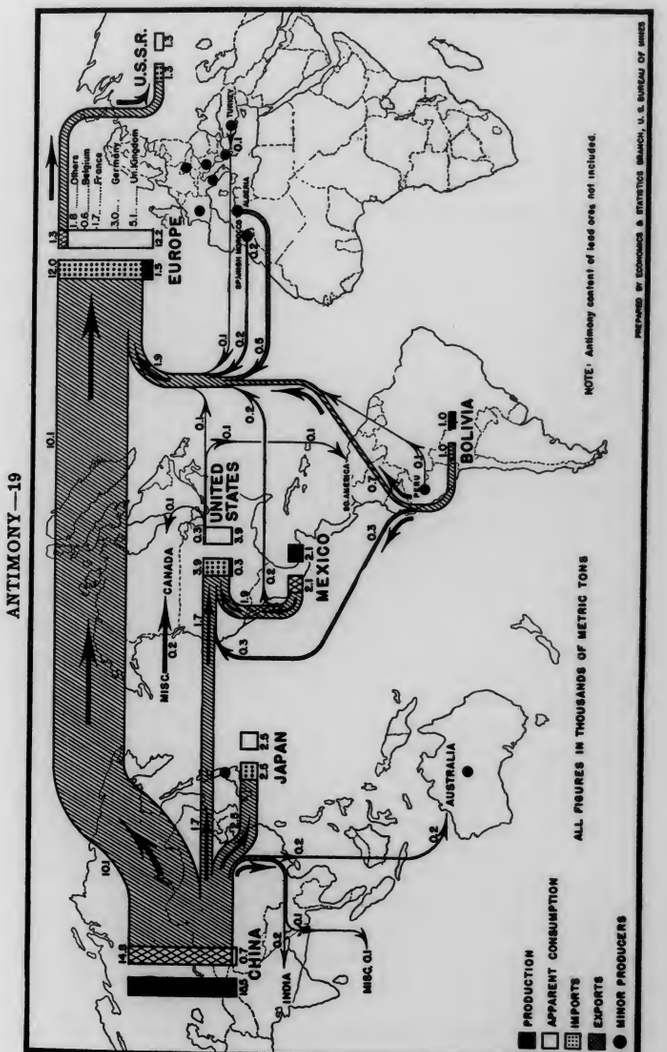
Reference

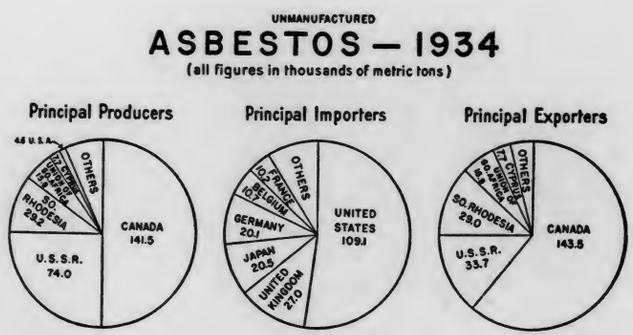
HENDERSON, H. P.: Antimony supply in war, *Military Eng.*, vol. 26, No. 147, May-June 1934, pp. 207–211.

WORLD PRODUCTION OF ANTIMONY, 1932–1934
(In Metric Tons)[1]

Country	1932	1933	1934
Algeria	214	80	529
Australia:			
New South Wales	61	42	10
Queensland	.....	[2]	.....
Bolivia[3]	1,176	1,517	961
China[4]	12,468	13,800	15,548
Chosen	3	8	.....
Czechoslovakia	480	1,090	928
France	510	312	202
Greece	262	110	73
Italy	302	291	249
Japan	16	32	26
Mexico[5]	1,388	1,559	2,134
Morocco, Spanish	121	120	247
Peru	14[3]	32	134
Turkey	.....	36	53
United States	304	426	293
Total	17,300	19,500	21,400

[1] Approximate recoverable metal content of ore produced (80 per cent of reported content) exclusive of antimonial lead ores except as otherwise noted.
[2] Less than one ton (434 kg.).
[3] Exports.
[4] Content of regulus, crude antimony, and oxide exported.
[5] Includes antimony content of antimonial lead.





The following minerals have been mined and sold under the name asbestos:

Serpentine asbestos.....	Chrysotile, $3MgO.2SiO_2.2H_2O$.
Amphibole asbestos.....	Actinolite, $Ca(Mg,Fe)_3(SiO_3)_4$
	Anthophyllite, $(Mg,Fe)SiO_3$
	Crocidolite, $NaFe(SiO_3)_2.FeSiO_3$
	Amosite, an iron-rich anthophyllite

Asbestos is not a distinct mineral species but a commercial term used to express the fibrous varieties of several minerals.

Chrysotile asbestos is preferred for manufacturing purposes because it is easily spun. Crocidolite is lower in heat resistance and spinability. Amosite fibers are harsher than chrysotile. Anthophyllite resists heat and acid as well as chrysotile, but is not so good as an insulating material. Chrysotile and crocidolite are the spinning fibers. Asbestos occurs in three different forms: (1) cross fibers in fissures; (2) slip fibers lying parallel to the walls of fracture planes; and (3) mass fibers in bunches.

The asbestos content of the rock may range up to 15 per cent, as in the case of the Rhodesian deposits. The Canadian deposits range from 6 to 12 per cent, with an average of 8 per cent asbestos. Russian and Cyprian deposits range from 5 to 10 per cent asbestos. Only a small percentage of the asbestos extracted is fit for

spinning. Strong, fine, flexible fibers must be ¼ in. long to have commercial value.

Asbestos is generally mined in open pits or quarries, very little underground mining being carried on. In Canada the deposits are worked in open pits. The rich deposits of Rhodesia, U.S.S.R., and Cyprus are worked as terraces on hillsides. The barren rock is sorted, and the asbestos-bearing rock is brought to the mill for crushing, drying, and careful separation from the country rock, after which it is conveyed to the classifying machines. In countries where labor is cheap a special effort is made to obtain the long fibers by hand sorting. The recent use of systematic and careful grading standards has received favorable approval from consumers.

WORLD PRODUCTION

Canada.—Centering around Thetford and Black Lake in the Province of Quebec are the largest asbestos deposits in the world. The mineral is found in a serpentine belt 23 miles long and 100 to 6,000 ft. wide. Early primitive mining methods have been abandoned for modern large-scale operations. Operating companies have been consolidated, with resulting economies in operation. The asbestos is very uniform in its chemical properties and therefore in its commercial properties. The Canadian deposits have the advantage of being located near relatively cheap transportation, and only short distances from large consuming centers; freightage costs and distance from market are serious drawbacks to most other large producers.

U.S.S.R. (Russia).—The asbestos deposits of Russia are in the Ural Mountains, principally in the Bajenova district, a region about 11 miles long and ½ mile wide, some 90 km. northeast of Sverdlovsk. Minor producing centers of the Urals are in the Alapaevsk area in the north and the Neviansk area in the northwest. The Minusinsk area, Siberia, is the only other large producer. The Russian asbestos deposits are comparatively rich in long-fiber varieties. Distance from centers of consumption retards the exploitation of these deposits.

Southern Rhodesia.—Excellent long-fibered asbestos is produced in the Shabanie and Mashaba district in Southern Rhodesia. The building of mills and railways will stimulate production to

meet the active demand. Presumably the production of short-fibered asbestos will also increase.

Union of South Africa.—In the Union of South Africa crocidolite is produced in the Cape of Good Hope some 20 miles southeast of Prieska. Chrysotile and tremolite are obtained in Natal. Amosite deposits occur in a belt 60 miles long and about 6 miles wide between Lydenburg and Pietersburg in Transvaal. Chrysotile is found in the Carolina district near Kaapsche Hoop 28 miles northwest of Barberton.

Cyprus.—Although the asbestos deposits of Cyprus are among the oldest known, production did not begin until after 1900. This was made possible by the discovery of deposits in the upper parts of the Trodos Mountains. Cheap labor and a favorable location on mountain slopes permit the extraction of very low grade short-fiber material. Recently, milling machinery has been introduced to facilitate production operations.

United States.—The asbestos deposits in the United States are not of sufficient magnitude to meet the demands, which are supplemented by imports. Production has tended to increase in quantity and at the same time to improve in quality. Commercial mining of asbestos has been carried on in Arizona, Maryland, Montana, Vermont, and Washington. Of recent years the Vermont deposits have been the most actively exploited in the United States.

Italy.—The Italian production comes from the Balangero deposits in mountainous country in Lombardy near Turin. Production has shown a noticeable increase. Although the fibers are long, they are not so usable as the softer, finer Canadian asbestos. Transportation problems beset the operators. The Union Asbestos Co. of London formerly managed nearly all of the mines, but recently they have passed into the control of Italian interests.

Other Countries.—Small amounts of asbestos are produced in Australia, Bulgaria, China, Chosen, Finland, France, Greece, British India, Japan, Swaziland, and Turkey.

Modern mining and milling practice and machinery have enlarged the quantity of reserves available by permitting utilization of lower grade material.

No estimates of world reserves are available. However, the reserves are known to be of sufficient magnitude to supply, at

the present rate of consumption, the demand for many years to come.

The principal producing countries, with the exception of Soviet Russia, consume only a small proportion of the asbestos they produce. The principal consuming nations, on the other hand, produce little or no asbestos; therefore, most of the asbestos produced enters into international trade.

According to Bowles,[1] the ownership of the Canadian companies is divided among English, United States, and Canadian interests. The amounts of capital invested by England and the United States are approximately the same, while the Canadian investment is less. British capital predominates in all the asbestos-producing companies of Southern Rhodesia and the Union of South Africa. The company operating in Cyprus is controlled by British capital. For many years a British company controlled most of the Italian production, but since 1929 an Italian company has operated the Balangero Mines, where the chief production is now centered.

INDUSTRIAL USES

The largest use of spinning asbestos woven from the fibers of chrysotile and crocidolite is for the manufacture of automobile brake-band linings and clutch facings. As much as 70,000,000 ft. of brake-band linings have been made in a single year in the United States. Gaskets consisting of asbestos cloth covered with rubber cement consume large quantities of spinning fiber. This grade is also used for the manufacture of fireproof theater curtains and scenery. The use of asbestos in aircraft is becoming increasingly important.

Nonspinning fiber, derived from the far less valuable minerals actinolite and anthophyllite, is used principally in the heat-insulation and roofing trade, although large quantities of the better grades are used for making molded brake linings. On account of its heat-insulating and fire-resisting properties, asbestos paper, manufactured in the same way as ordinary paper, is used for making three-ply air-cell and similar pipe covering, as sheeting between floors, and as lining for stoves and heaters. Asbestos compounds are used to some extent in automobile

[1] Bowles, O., Asbestos, *U. S. Bur. Mines, Inf. Circ.* 6817, January 1935, p. 16.

bodies. Asbestos-cement pipes are finding increasing use for water and gas mains and sewers. They are resistant to acids, noncorrosive, relatively nonconductive of heat and electricity, light in weight, and so elastic that traffic vibrations are unlikely to cause leakage. Moreover, they are easily placed and joined.

Roofing shingles consisting of about 85 per cent portland cement and 15 per cent asbestos are used extensively. Large quantities of short fibers are consumed in the manufacture of plastic fireproof cements used for boiler, pipe, and furnace covering. The stronger grades of anthophyllite are used for making acid filters, stoppings in combustion tubes, wicks for producing flames by saturation with mineral salts, fireproof supports and protectors, and other chemical-laboratory equipment. Weak, brittle amphibole asbestos is used in making plastic cements and as an ingredient in acoustical and other wall plaster, cement flooring, and battery boxes, but it cannot be used in shingles and compressed sheets where fiber strength is important. Many industries use asbestos for hundreds of minor purposes.

SUBSTITUTES

There are substitutes for heat and cold insulation, but for the electrical and industrial uses, as well as for fireproofing, asbestos is believed indispensable.

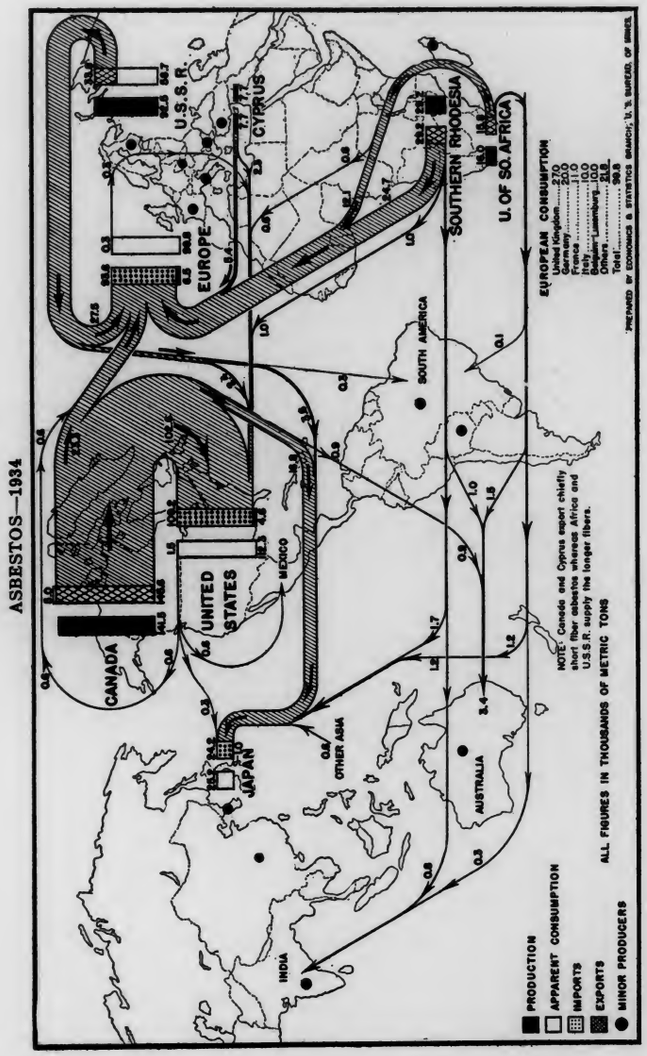
Reference

Ross, J. G.: Chrysotile asbestos in Canada, *Can. Dept. Mines, Mines Branch, Pub.* 707, 1931, 146 pp.

WORLD PRODUCTION OF ASBESTOS, 1932–1934
(In Metric Tons)[1]

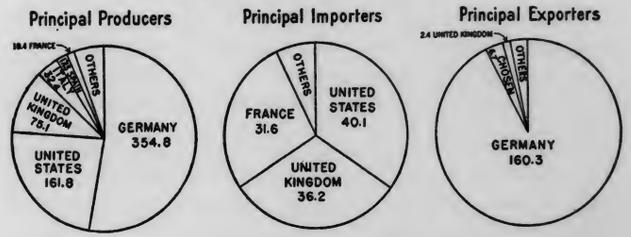
Country	1932	1933	1934
Argentina[2]	7	.....	.....
Australia:			
South Australia	20	13	.....
Western Australia	112	270	157
Bulgaria	.....	.....	3
Canada[3]	111,562	143,667	141,502
China[4]	500	500	500
Chosen	.....	12	4
Cyprus[5]	1,626	4,640	7,712
Finland	756	1,340	1,735
France	300	[6]	[6]
Greece	9	14	30
India, British	91	.....	25
Italy	1,284	3,267	2,252
Japan[7]	1,000	1,000	1,000
Southern Rhodesia	14,303	27,381	29,224
Swaziland	5	.....	.....
Turkey	58	120	4
Union of South Africa	10,950	14,411	15,960
U.S.S.R. (Russia)	60,000	74,000	[6]
United States (sold or used by producers)	3,229	4,305	4,615
Total	205,812	274,940	204,723

[1] In addition to the countries listed, Bolivia, Brazil, and Madagascar are reported to produce small quantities of asbestos.
[2] Rail and river shipments.
[3] Exclusive of sand and gravel, production of which is reported as follows: 1932, 3,151 tons; 1933, 5,850 tons; 1934, 4,238 tons.
[4] As estimated by Imperial Institute, London.
[5] Exports.
[6] Data not available.
[7] Approximate production.



BARITE – 1934

(all figures in thousands of metric tons)



Barite or barium sulphate ($BaSO_4$) is a vein-forming mineral or a gangue mineral accompanying base sulphide ores. Barite veins may be quite pure or mixed with fluorite, calcite, quartz, and the sulphides of lead and zinc. Barite also occurs as a residual product formed by the weathering of underlying barium-bearing limestones. The residual barite is closely associated with clays. Barium carbonate or witherite ($BaCO_3$) is found in vein formations. The mineral is of rarer occurrence than is barite.

The United States, once the world's largest producer of barite, was surpassed by Germany in 1933. New industries and new uses account for the rapidly increasing production. Germany has been able to regain most of the trade that was lost by the World War.

PRINCIPAL DEPOSITS

Germany.—The German deposits of the vein type occur in the Thüringian Forest, the Black Forest, Odenwald, Hesse, and the Bavarian Palatinate. Very pure barite is found in Soutra, Hesse, and Herges-Togtei in the Thüringian Forest. The largest deposits are of the bedded type, being mined at Meggen-on-the-Lenne, Westphalia. Witherite is also mined in Thüringia. High-grade deposits and proximity to large markets make Germany the foremost barite-producing nation.

United States.—The barite deposits of the United States are located in three districts: (1) The Pacific Coast district, comprising California and Nevada; (2) the Middle Western district, represented by the largest producer, Missouri; and (3) the Southern or Appalachian district, embracing Georgia, Tennessee, North and South Carolina, and Virginia. The deposits of the Pacific Coast are of the vein type, while those of the Middle West and the East are associated with clays representing the residues of weathered limestone and dolomite.

United Kingdom.—Barite is produced in the United Kingdom in Northumberland, Durham, Cumberland, Westmoreland, and Yorkshire. The Settlingstones mine in Northumberland, originally worked for lead, is now the world's chief source of witherite. The output of this mine amounted to 6,358 metric tons in 1932, 5,193 in 1933, and 10,579 in 1934. Reserves sufficient to last several decades are known.

Italy.—Several districts produce barite in Italy proper and in Sardinia. The most important are the Carrara, Milano, and Trento districts, and the Iglesias district of Sardinia.

France.—Barite is produced in France from the Central Massif region.

Spain.—Barite occurs generally associated with lead-bearing ores of Spain in the provinces of Almeria, Gerona, and Tarragona.

Chosen.—In Chosen large veins of barite of an excellent quality are found in limestone at Shodore, Kinka district, Kogen Province.

Other Countries.—Other countries producing minor amounts of barite are Algeria, Australia (of which South Australia is the largest producer), Austria, Canada, and British India.

INDUSTRIAL USES

Barium metal has, broadly speaking, no industrial uses and at present is of academic interest only. Barium compounds, prepared from barites or barite, barium sulphate, and barium carbonate (witherite) are, however, important industrially.

The industrial uses of barites are such that their utilization is a convenience, but not a necessity. Commercial utilization may be divided into three groups: ground barite, lithopone, and barium chemicals. Ground barite is used chiefly as an inert filler in paper, rubber, cloth, linoleum, and oilcloth. It is used in making artificial ivory and buttons and in the ceramic industry for glazing

and enameling purposes. Small amounts are used in the manufacture of certain types of glass.

Lithopone is a white pigment, which consists of approximately 70 per cent barium sulphate and 30 per cent zinc sulphide. Barite is employed as an adulterant in the manufacture of automobile tires, rubber matting, fruit-jar rings, and tubing.

Chemicals derived from barium ores may be produced from either barites or witherite. The most important of these are barium sulphate, known as blanc fixe, barium carbonate, and barium nitrate.

Reference

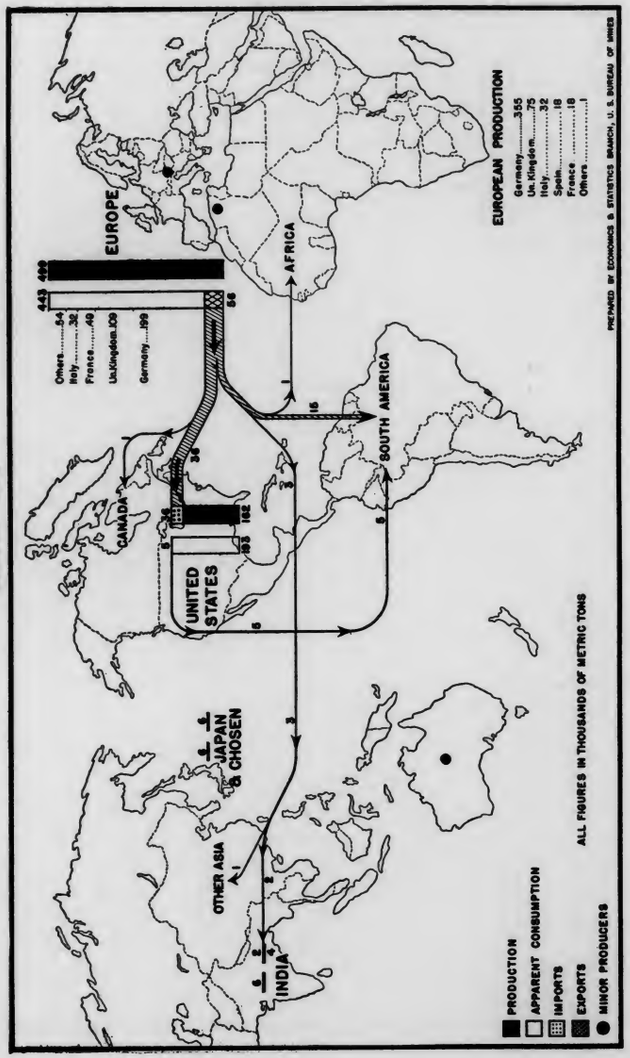
SANTMYERS, R. M.: Barite and barium products, *U. S. Bur. Mines, Inf. Circ.* 6221, January 1930, 55 pp.; *Inf. Circ.* 6223, February 1930, 26 pp.

WORLD PRODUCTION OF BARITE, 1932–1934
(In Metric Tons)

Country	1932	1933	1934
Algeria	890	10	.....
Australia:			
New South Wales	309	323	187
South Australia	1,728	1,800	2,345
Tasmania	.....	5	.....
Austria	275	1,030	1,025
Canada	.....	18	.....
Chosen	6,569	4,969	5,935
France	10,400	[1]	[1]
Germany:			
Baden	[1]	[1]	19,681
Bavaria	5,853	4,146	8,385
Prussia[2]	102,167	143,465	326,318
Saxony	2,446	130	484
India, British	3,004	5,742	3,874
Italy	21,861	23,444	32,408
Portugal	.....	2	1
Southern Rhodesia	.....	.....	14
Spain	8,934	4,605	17,528
United Kingdom	57,548	67,689	75,182
United States	121,174	132,813	161,806
Total	343,158	390,191	655,173

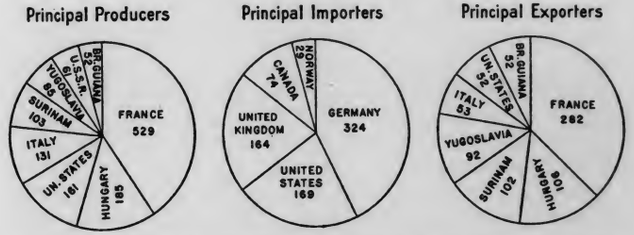
[1] Data not available.
[2] Official figures which, it is reported, cover only output of mines included under the mining law.

BARITE—1934



BAUXITE — 1934

(all figures in thousands of metric tons)



Bauxite, the chief commercial source of alumina, is composed essentially of a mixture of diaspore, bohmite, and gibbsite, and owes its preeminent position to its high alumina content and relatively low content of silica, iron, and other impurities. A typical bauxite contains 55 to 65 per cent alumina, 2 to 5 per cent silica, 1 to 25 per cent ferric oxide, 1 to 3 per cent titanium oxide, and 10 to 30 per cent combined water. About 2 tons of bauxite is required to make 1 ton of alumina; 2 tons of alumina, in turn, is required to produce 1 ton of aluminum. Based upon present-day metallurgical knowledge, the reduction of bauxite requires an abundance of cheap electrical power.

PRINCIPAL DEPOSITS

France.—The bauxite and aluminum industry of France is on the east side of the Rhone Valley near the Italian and Swiss boundaries. Most of the bauxite is produced in the Department of Var; it is also mined in the Departments of Herault, Ariège, and Bouches-du-Rhône. The French bauxite is considered to be of excellent grade, owing to its high percentage of alumina and very low silica content. A decree of Apr. 16, 1935, placed the exportation from France of bauxite, alumina, and aluminum under the jurisdiction of the Minister of Finance.

United States.—In the United States alumina is made from Arkansas bauxites and ore imported from Surinam (Dutch

Guiana). The reduction plant is at East St. Louis; and the product, alumina, is shipped to Niagara Falls and Massena, N. Y., Alcoa near Knoxville, Tenn., and Badin, N. C., as well as to Canada and Norway for reduction to metallic aluminum. Bauxite is also mined in Georgia, whence it is shipped to various plants in the United States engaged in the manufacture of abrasives, cement, and chemicals. Over 90 per cent of the bauxite produced in the United States comes from Arkansas. A rough estimate shows deposits of commercial-grade bauxite sufficient to last 30 to 40 years at the present rate of consumption.

Hungary.—Large deposits of bauxite occur in central Hungary. Part of the bauxite mined is used in the manufacture of cement; all the remainder has been exported, the greater part being shipped to Germany.

Surinam.—Much of the bauxite treated for the manufacture of alumina in the United States comes from the extensive, high-grade deposits of Surinam. These deposits, controlled by American capital, are situated in the Paramaribo region about 15 to 100 miles from the coast.

Italy.—The bauxite deposits of Italy now being mined are in Istria, but the bauxite zone continues into the island fringe of the Dalmatian coast of Yugoslavia. The bauxite deposits of the Italian mainland are not exploited but are probably held in reserve. Since 1928 the export of Istrian bauxite has been controlled by the government.

Yugoslavia.—In Dalmatia, Hercegovina, and Montenegro, Yugoslavia has large reserves of bauxite similar in occurrence to that of Istria. All the bauxite is exported at present, most of it going to Germany.

British Guiana.—The deposits in British Guiana are quite similar to those of Surinam. They are largely controlled by The Aluminium, Ltd., and the portion of the output that is used for the manufacture of aluminum is shipped to Canada.

U.S.S.R. (Russia).—There are bauxite deposits at Tikhvin in the northwestern part of the Union of Soviet Socialist Republics and on the eastern slopes of the Ural Mountains in western Siberia. Exploitation of the former deposits has now begun, whereas the latter deposits are still being prospected. Extensive deposits of nepheline, produced as a by-product of the apatite industry, occur in the Kola Peninsula of Artic Russia. Plants

are planned to convert the bauxite of the Urals and the nepheline of the Kola Peninsula into alumina.

Germany.—Bauxite is produced in relatively small amounts in Upper Hesse at the Albert mine near Vogelsberg, Germany. Probably lack of necessity and a low price for aluminum rather than technology prevent the use of clay as a raw material for the manufacture of aluminum. The German bauxite is used in the manufacture of cement and abrasives. Owing to export restrictions the bauxite is now imported, chiefly from Yugoslavia and Hungary.

Greece.—The principal deposits of the Greek mainland occur along the north shore of the Gulf of Corinth. There are also bauxite deposits on the Island of Amorgos in the Aegean Sea.

Netherland India.—New sources of bauxite just entering production in Netherland India are two—the island of Bintan near Singapore and the Island of Banka off the east coast of Sumatra. The bauxite will be exported to Europe and to Japan.

Other Countries.—A small amount of bauxite is produced in New South Wales and Victoria (Australia), British India, Rumania, Spain, and Northern Ireland.

INDUSTRIAL USES

Approximately one-third of the world production of bauxite is used for the production of metallic aluminum, and the ever-increasing demand for bauxite evidences the important place occupied by aluminum in the industrial world. The second largest consuming use of bauxite is in the manufacture of aluminous cement. The type required for this purpose must be low in silica, contain only a moderate amount of iron, and be relatively free from other impurities. When aluminous cements first came into use, they were manufactured to resist the action of saline waters so destructive to the average run of portland cement. No other hydraulic cement gives the early strength of that manufactured from aluminous cements. This valuable quality makes this type of cement essential where strength is desired in a comparatively short time.

Refractories manufactured from bauxite are used extensively for linings in metallurgical furnaces, as well as in the kilns used in the manufacture of high-lime cements.

Prior to 1900 natural corundum and emery were the best abrasives known, as they rank next to diamond in the Mohs' scale of hardness. Since 1900, artificial abrasives have been introduced, and in the United States approximately 15 to 20 per cent of the total amount of bauxite consumed goes into the manufacture of such material as alundum and aloxite—trade names for artificial abrasives. The bauxite used is of lower grade than that employed for the production of aluminum. It is mixed with coke and iron borings and smelted in an arc furnace.

Sulphate of alumina is required in the dyeing and color-making industries. The property this chemical possesses, necessary to meet this industrial requirement, is that colloidal alumina absorbs other colloids. The compound thus formed has great stability.

Bauxite is used in the manufacture of aluminum chloride, acetate, oleate, and stearate. In the conversion of ethyl alcohol to ethylene and in the other organic reactions bauxite and alumina are used as catalysts.

As deposits of bauxite constitute the source from which the larger part of the world's production of aluminum is obtained, the reserves of this mineral are of utmost importance not only during emergencies but also in peace times.

SUBSTITUTES

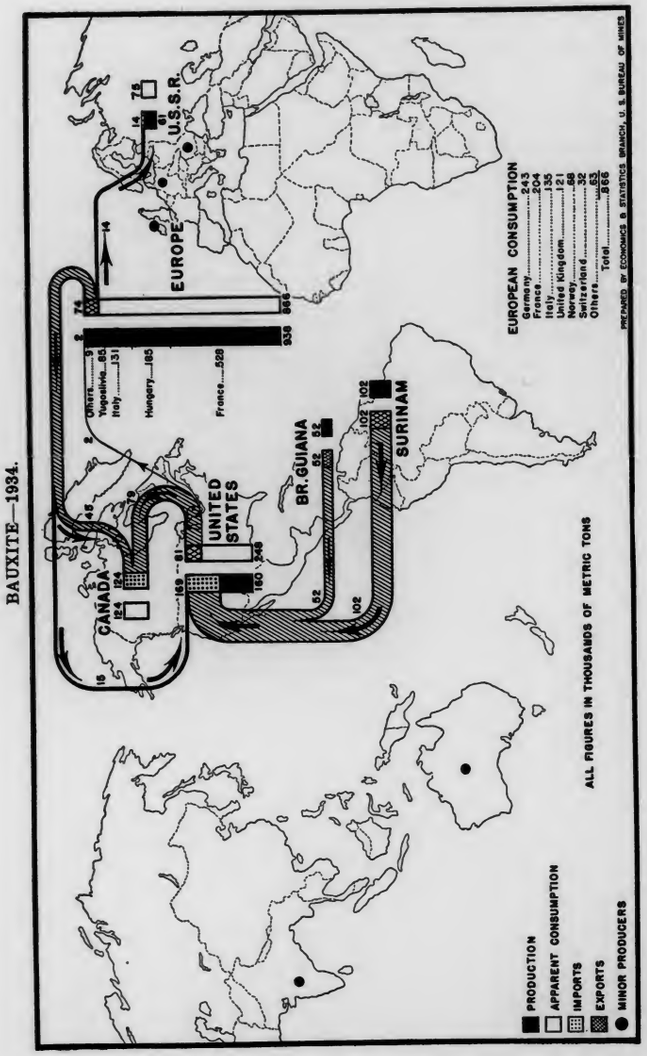
Alunite, leucite, and other aluminum-bearing minerals may be used as substitutes for bauxite, but cost of production is very much higher.

WORLD PRODUCTION OF BAUXITE, 1932–1934
(In Metric Tons)

Country	1932	1933	1934
Australia:			
New South Wales	.....	333	161
Victoria	1,147	681	970
British Guiana[1]	63,510	36,663	51,417
France	401,430	490,500	528,400
Germany	1,638	[2]	6,560
Greece	590	.....	.....
Hungary	111,558	72,425	184,991
India, British	4,539	1,092	18
Italy	86,553	94,818	131,266
Rumania	612	1,156	1,458
Spain	1,300	2,500	.....
Surinam (Dutch Guiana)	126,513	103,977	103,338
U.S.S.R. (Russia)	37,400	50,600	61,000
United Kingdom: Northern Ireland	1,497	709	58
United States	97,895	156,651	160,371
Yugoslavia	67,086	80,855	84,828
Total	1,003,000	1,098,000	1,315,000

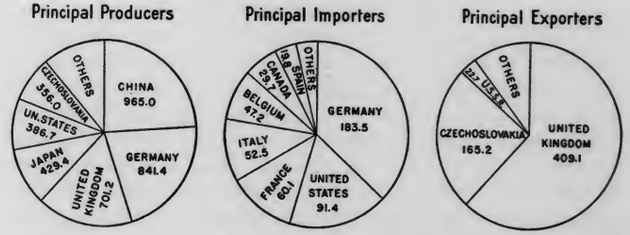
[1] Exports.
[2] Estimate included in total.

BAUXITE—1934.



CHINA CLAY — 1934

(all figures in thousands of metric tons)



Kaolinite or china clay ($Al_2O_3.2SiO_2.2H_2O$), a hydrated silicate of alumina, is a secondary mineral formed at low temperatures by percolating solutions, causing the decomposition of feldspar. Kaolin is used in the manufacture of chinaware, as it gives stability to the article and resists high temperatures.

WORLD PRODUCTION

China.—This country is the largest producer of china clay, the principal center of production being in the Kiangsi Province in the Kingtehchen district. The manufacture of chinaware in this region is said to date from 220 A.D. The industry has grown to large dimensions, and at one time employed a million people. Over a dozen kinds of clays are utilized. "Bone" clay or kaolin formed from decomposed feldspar or granite gives strength and brittleness to the article. "Flesh" clay formed from a mixture of feldspar and quartz gives resilience and toughness to the product. These two clay types must be mixed in the right proportion, or the vessels will crack and sag. The industry is largely in the hands of families which follow traditions and inherited methods. Straw and wood are used as fuels to avoid discoloration of the wares. The fuel problem is most acute, as the surrounding country has been deforested, and the straw and wood must now be brought from distances as great as several hundred miles.

In Anhwei Province there is an old porcelain industry that uses the high-grade kaolins of the Chimen district. The principal part of the output goes to Kingtehchen district of Kiangsi. Next in importance to the Kingtehchen district is the Te Hwa region in the interior of Fukien Province. Inferior deposits occur in the Ningteh, Mintsing, and Kutien districts of this province. The large Poshan deposits near Shantung are under Japanese interests. Other clays of good quality are found in the provinces of Kiangsu, Honan, Hopeh, Shensi, Kansu, and Manchuria.

United Kingdom.—Although there are extensive deposits of kaolin in southwestern England, only the high-grade occurrences have been carefully explored.[1] These deposits extend to depths below the present limits of commercial mining. The crude kaolin contains 12 to 30 per cent of clay substance, the average content worked being 20 to 25 per cent. The English deposits rank with any in the world owing to (1) the large size and location of the deposits near the surface, their situation relatively near the sea, and their accessibility to cheap transportation; (2) careful preliminary preparation and uniformity of the product; and (3) high average quality and good color of the clay compared with the average kaolin from any other district, except the best Bohemian kaolins. The kaolin deposits are considered by Lilley[2] to be due to the alteration of granites by ascending hot solutions. American capital has obtained control of some of the deposits.

Germany.—At least two types of kaolin deposits are found in Germany—in Saxony, in the adjoining regions of Prussia, and in Bavaria. These residual kaolin deposits lie like a blanket on underlying decomposed granite and are covered with Tertiary lignite seams. The formation of organic acids by the decomposing lignites is believed to have aided in the decomposition of the underlying granites to form the blanket of kaolin. Dresden, Meissen, Aue, Wurzen, Halle, and Kemmlitz, in this kaolin-bearing region paralleling the northern slope of the Erz Gebirge of Germany, have long been famous as centers for the production of high-grade kaolins and porcelain ware.

The second type of deposit is that of the kolinized arkosic sandstones near Oberfälz or the Amberg district of Bavaria.

[1] LILLEY, E. R., The geology of some kaolins of western Europe, *A.I.M.E., Tech. Pub.* 475, 1932, 22 pp.

[2] LILLEY, E. R., The geology of some kaolins of western Europe, *A.I.M.E. Tech. Pub.* 475, 1932, p. 19.

Japan.—The china clay deposits of Japan have been formed by the decomposition of granites and the weathering of certain lavas. The center of the clay industry is at Nagoya, where two-thirds of the country's output of pottery is produced.

United States.—The principal occurrences and kaolin plants of the United States are in Pennsylvania, New Jersey, Maryland, North and South Carolina, Georgia, and Florida. These deposits are largely sedimentary clays formed by the weathering of feldspar.

Czechoslovakia.—The Plzen basin is the chief source of kaolin in Czechoslovakia. China clay is believed to have been formed by the alteration *in situ* of feldspars in the arkosic sandstone. This alteration was facilitated by means of organic acid-bearing solutions percolating downward from overlying lignite beds.

France.—The larger part of the china clay production of France comes from the Department of Morbihan, Brittany, and another considerable portion from the Department of Allier and the Drome Department, in south central and southeastern France, respectively.

Italy.—About half of the china clay produced in Italy was mined in the Iglesias district of Sardinia. On the mainland about one-third of the production is obtained from the Padova district west of Venice. The remainding output comes from a series of scattered deposits.

Other Countries.—China clay is also produced in Algeria, Australia, Belgium, British India, Bulgaria, Chosen, Denmark, Netherland India, Portugal, Rumania, Spain, Sweden, the Unfederated Malay States, and the Union of South Africa.

INDUSTRIAL USES

China clay has been so named because it is the material from which the larger part of all chinaware is produced. Both china clay and kaolin are used in the manufacture of porcelain. In the equipment of high-power transmission lines, as well as in transformer stations, insulating parts of china clay are considered essential.

The principal uses of this mineral are in the manufacture of ceramic products and in the manufacture of paper as a filler and surfacing material. In the manufacture of earthenware, china clay gives added whiteness to the body and is more plastic than flint, an agent used for the same purpose. Porcelain is said to

be the noblest kind of pottery, its distinguishing feature being a vitrified, impervious, and translucent body. There are many varieties of porcelain, which differ widely from one another, as for example, hard porcelain, soft or tender porcelain, china or bone porcelain, etc.

The well-known English china or bone china consists of approximateiy 30 per cent china clay, mixed with bone ash and china stone. Porcelain for the electrical trade must be made with special care. Hard porcelain meets this requirement. When used for this purpose it must be fired at the highest temperature possible, and the ware must be rich in sillimanite, $Al(AlO)SiO_4$.

SUBSTITUTES

In the manufacture of chinaware and paper, substitutes may be used, but these will produce inferior grades. In the manufacture of insulators for the transmission of electrical current there is no known substitute.

References

RIES, H.: Clays, their occurrence, properties, and uses, 3d ed., New York, 1927, 613 pp.

TYLER, P. M.: Clay, *U. S. Bur. Mines, Inf. Circ.* 6155, July 1929, 63 pp.

WORLD PRODUCTION OF CHINA CLAY, 1932–1934
(In Metric Tons)[1]

Country[2]	1932	1933	1934
Algeria	1,800	[3]	[3]
Australia	5,192	8,613	8,927
Belgium[4]	9,720	13,870	14,520
Bulgaria	2,836	2,659	2,780
Canada	.....	.....	44
Chosen	12,011	24,930	23,421
Czechoslovakia (estimated)	356,000	356,000	356,000
Denmark: Crude	29,800	34,900	43,100
Washed and pressed	8,600	8,700	11,400
Dried	800	700	700
France	100,400	[3]	[3]
Germany:			
Bavaria	379,718	474,958	688,157
Prussia	8,486	12,153	62,785
Saxony: Crude	108,419	42,676	36,517
Washed	28,084	33,432	43,745
Sand	[3]	[3]	10,276
India, British	13,702	22,287	20,892
Italy: Crude	30,688	21,208	36,500
Washed and ground[5]	8,338	4,073	[3]
Kaolinic earth	800	1,600	1,330
Japan (estimated)	406,000	406,000	406,000
Netherland India	122	233	[3]
Portugal	6,872	9.567	11,831
Rumania[6]	8,258	10,376	14,779
Spain[7]	1,170	1,570	1,370
Sweden	1,411	1,908	2,374
Unfederated Malay States	189	37	143
Union of South Africa	.....	.....	375
United Kingdom	517,017	606,185	701,206
United States[8]	312,972	373,062	386,763
China[9]	862,706	943,720	965,000
Total	3,222,111	3,415,417	3,850,935

[1] Adapted from figures as published by Imperial Institute, London, converted to metric tons on the basis of 1 long ton = 1.01605 metric tons.

[2] In addition to the countries listed, china clay is also produced in Austria and U.S.S.R. (Russia), but production data are not available.

[3] Data not available.

[4] "Eurite" and kaolin.

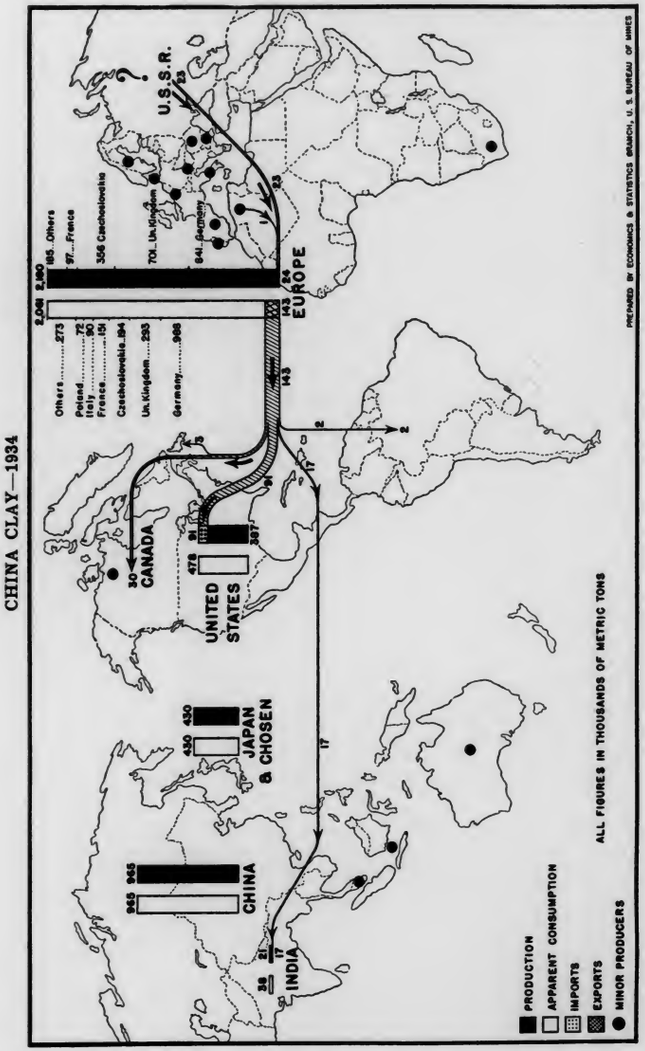
[5] Derived from crude and stocks.

[6] Converted from cubic meters at the rate of 1 cu. m. = 2 long tons.

[7] The following quantities of kaolinic sand were also produced: 1932, 3,940 cu. m.; 1934 4,540 cu. m.

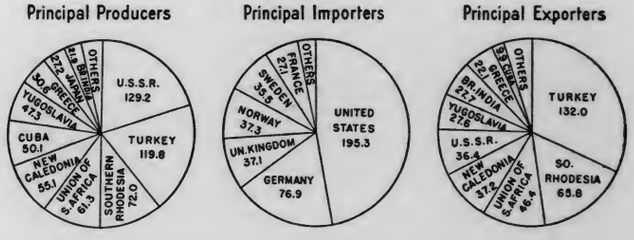
[8] Sales of kaolin or china clay and paper clay.

[9] Kaolin and fireclay as reported by the Geological Survey of China.



CHROMITE — 1934

(all figures in thousands of metric tons)



Chromite is composed of chromium, iron, and oxygen. It is the ore of commerce from which chromium is produced. In lower grade ores part of the ferrous oxide is replaced by magnesium oxide and part of the chromium oxide by aluminum or ferric oxide. Chromite is formed by segregation and crystallization in molten rock and is generally to be found in igneous rocks composed of olivine and pyroxene or of serpentine produced from these minerals by alteration. Most chromite deposits are lenses or tabular masses. The lenses may consist almost entirely of chromite, or they may be composed in part of barren rock through which the grains or masses of chromite are irregularly disseminated. Veins or dikelike bodies of ore were formed by the cooling and crystallization of the chromite, from a molten solution, in fractures that pass through an earlier body of ore of the bordering wall rock.

PRINCIPAL DEPOSITS

U.S.S.R. (Russia).—Chromite deposits of the Union of Soviet Socialist Republics occur in the Ural Mountains and in the northern part of the Caucasus Range. Most of the ore mined comes from the region of Perm, though some chromite is mined in the Orenburg district of the Urals. The most important deposits are those around Khalilovo in Bashkir; the chromic

oxide content of the ore ranges from 20 to 46 per cent Consumption is recorded in the form of bichromates at Shaitansky or in the manufacture of steel at Chelyabinsk.

Turkey.—Widely separated chromite-bearing rocks occur in western Turkey. The principal deposits are southeast of Istanbul in the Eskishehir district. Others are found in the southern part of western Turkey at Mersin and in the Fethiye or Makri district. The chromic oxide content of the ores varies considerably with the different mines, some carrying 50 to 52 per cent chromic oxide and others, 43 to 50 per cent. Further development may result from the extension of railroads in this region.

New Caledonia.—Chromite was discovered in New Caledonia in 1866 and was first mined there at Mont d'Or near Nouméa in 1875. Since that time about one-fifth of the world's chromite has come from these deposits. The most productive mines are at Mount Tiebaghi, on the northwest end of the island, and at its southeastern end from Nouméa to Prony Bay. The ore is both "rock chrome" and "alluvial chrome," most of which is of residual (untransported) origin. The "alluvial chrome" as a rule contains 30 to 40 per cent chromic oxide, which is raised by concentrating to 50 per cent before it is marketed. The "rock chrome" contains an average of 55 per cent chromic oxide. The deposits of higher grade ores are the world's main supply for chemical purposes. The principal deposits are commercially controlled by United States, British, Japanese, and French capital. Production has declined since the World War, owing to transportation difficulties and the remoteness of the deposits.

Southern Rhodesia.—The chromite deposits of Southern Rhodesia are in the southern part along a belt about 200 miles long extending from Lomagundi to Victoria. Nearly four-fifths of all the ore comes from Mashaba, in the Gwelo district. This belt also includes the Lomagundi, Victoria, and Hartley districts. The ores are composed of about 45 to 55 per cent chromic oxide. Development of these deposits has been retarded by lack of cheap transportation. Since there is no local consumption of the chromite all of it is shipped by rail to Biera, Portuguese East Africa, and thence overseas.

Yugoslavia.—The output of chromite from this country comes from north central Serbia and extends southward along the Kapaonik Mountains into Greece.

Union of South Africa.—Recently large reserves of chromite have been developed in the Union of South Africa at Rustenburg and Lydenburg in the Transvaal. Shipments for export are made to Lourenço Marques in Portuguese East Africa. The ores are rather low grade, averaging about 43 per cent chromic oxide, and are used chiefly by refractory industries.

Within the last few years a small amount of high-grade ore has been shipped from the Istillo range of Natal.

Cuba.—Although chromite occurs in several localities in Cuba, the deposits in Camaguey Province are the most important. The ore is low grade, containing 33 to 43 per cent chromic oxide, and is used principally for refractories.

Japan.—Chromite production is gradually increasing in Japan, and, although never large, is sufficient to render Japan independent of foreign supplies.

British India.—The Hassan chromite deposits of Mysore are the largest in British India. The Mysore deposits, also located in Mysore, are smaller, but the production has been steadier than that of Hassan. The chromic oxide content of the ore averages 52 to 53 per cent. The deposits of Zhob, in the upper valley of the Pishin River of Baluchistan, rank second in production, and their chromium content is quite high. World War demands gave an impetus to the development of these ores, but production has since declined owing to lack of demand. The Chaibassa district of Singhbhum produces ores carrying 50 per cent or more chromic oxide. The ore horizon is persistent but not large. Some consideration has been given the possibility of concentrating the lower grade ores. The output, though small, has been quite steady.

Greece.—The production of chromite in Greece, though of long standing, has never been large. The deposits occur along the east coast and represent the southward continuation of the Serbian chromite belt. The ores occur in two forms: as massive deposits in serpentine and as chromiferous iron ore. The occurrences are numerous but small, and the larger part of the output comes from Thessaly. Most Greek ore is of moderate grade, running 38 to 42 per cent chromic oxide, and is used principally in the manufacture of refractory products.

Guatemala.—Chromite is produced at irregular intervals from high-grade deposits in the Jalapa district of Guatemala.

These deposits are controlled by a company in the United States.

Australia.—Chromite production in New South Wales, Australia, has shown considerable increase.

Cyprus.—Production of chromite from the Island of Cyprus has been very irregular in quantity.

Canada.—Chromite is mined in Canada in the Thetford-Black Lake area of the Eastern Townships of Quebec. Northwestern Ontario is a new producer, the chromite coming from near Obonga Lake 25 miles south of Collins Station on the Canadian National Railway. The ores are shipped to Sault Ste. Marie for smelting.

Philippine Islands.—The first commercial shipment of chromite from the Philippine Islands was made to the United States in October 1935. The deposits are 10 km. northwest of Lagonoy in Camarines Sur. The ore analyzed over 53 per cent chromic oxide.

United States.—Chromite was discovered in the United States in 1828; the deposits were developed rapidly, and this country was the chief source of the world's supply until 1860, or soon thereafter, when Turkey replaced it. Ore was mined first in Maryland and Pennsylvania and later in California. Competition with the Turkish deposits resulted in the cessation of mining in Maryland. At the present time the United States production comes from scattered deposits in California and Montana.

Other Countries.—There are other deposits of chromite in Algeria, Argentina, Borneo, Brazil, Celebes, Ceylon, Chosen, Colombia, Czechoslovakia, Egypt, France, Germany, Greenland, Hispaniola, Indo-China, Iran, Italy, Mexico, Newfoundland, New Zealand, Norway, Palestine, Portugal, Rumania, Scotland, Sierra Leone, Spain, Sweden, Syria, and Togoland. The most important deposits are those of Brazil, Indo-China, Norway, and Rumania. Some of these produced chromite during the World War.

INDUSTRIAL USES

During the past 30 years the importance of chromium in the industrial world has increased. Its use as a chemical has long been known, but its adaptation as an alloying metal in steel is of comparatively recent development. The possible influence of this metal on the future of the steel industry may be realized when consideration is given to an outstanding characteristic, namely, resistance to corrosion and abrasion, which thus retards dissipation of steel by weathering. The broadening of the market for chromium steels may prove to be an important factor in the conservation of the world's high-grade iron-ore resources.

The most important application of chromite ores is in the manufacture of ferrochrome, the alloy used in making chromium steel. The chromium content in average chrome steel is approximately 2 per cent. This class of steel absorbs the largest tonnage of chromium used in the steel industry. Chromium alloys are extremely hard and tough but can be bent while cold or welded to iron to form either a hard surface or a core virtually impenetrable to the finest drilling tools. Steel containing either chromium alone or chromium alloyed with such metals as nickel, vanadium, tungsten, and manganese are used for armor plate, armor-piercing projectile, and machinery subjected to abrasive action. Steels containing 5 to 6 per cent chromium have been advertised as nonrusting. Steels known commercially as "rustless" contain 13 to 18 per cent chromium. These are said to be noncorrosive in the presence of water, air, and certain acids. This alloy used extensively in the manufacture of exhaust valves, turbine blades, pump rods, rollers for bearings, electric heating stoves, and cooking utensils.

Alloys of chromium, cobalt, tungsten, or molybdenum are known as "stellite" and are employed largely for high-speed tool steel. These metals impart to steel the ability to retain their hardness and cutting edge at high temperatures when run at speeds at which ordinary carbon tool steel would soften owing to heat caused by friction. Chromium is used extensively in the plating industry. The surface is hard and white, is resistant to the action of ammonia fumes, hydrogen sulphide, and nitric acid, and is not attacked by molten zinc, tin, or brass.

By far the largest consumption of chromite is in the manufacture of refractories used as a lining for furnaces. The utilization of chromite in the form of bricks and special shapes is not a necessity but has come into general use because the bricks do not soften readily in the heat of the furnaces and contaminate the melts. As the qualities of the metal chromium become better known in industry, consumption of the mineral chromite for

refractory purposes may be curtailed. The chromite used for refractory purposes is dissipated and rendered unrecoverable after a limited period. On the other hand, chromium steels may be reclaimed and used until actual dissipation by abrasion is completed.

Chromite is of great importance to the chemical industry. From it is obtained the chromium used for making chromates and bichromates. Chrome pigments—yellow, green, and red—are widely used. In the dye industry, the soluble chromates and bichromates are used as mordants. Chromates are also used in tanning chrome leather and in bleaching fats and oils. In the ceramic industry chromic acid and bichromates are used to color pottery.

In the manufacture of chrome alloy steel, ferrochrome is invariably employed. The use of chrome for the manufacture of projectiles, armor plate, rifle linings, high-speed tool steel, automobile axles and springs, locomotive frames and springs, and in general where steel parts must stand hard usage, indicates its importance from a military standpoint.

SUBSTITUTES

For the manufacture of certain steels there is no known substitute for chromium. In tanning, no satisfactory substitute has been found. Chromates for pigments may be replaced, but as a rule (to which the exceptions are few) substitutes are more expensive. As a refractory, chromite competes commercially with and may be replaced by other materials.

Reference

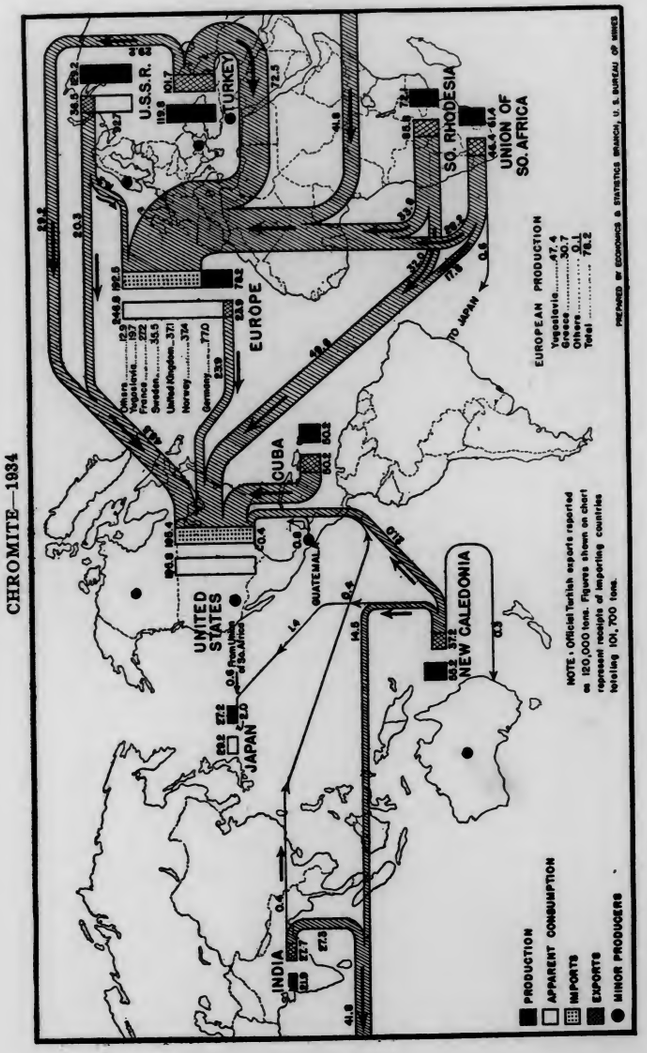
Smith, L. A.: World production and resources of chromite, *Trans. A.I.M.E.*, 1931, pp. 376–402.

World Production of Chromite, 1932–1934
(In Metric Tons)

Country	1932	1933	1934
Australia	99	905	1,744
Bulgaria	.....	.....	85
Canada[1]	71	27	101
Cuba[2]	.....	24,154	50,162
Cyprus[1]	1,000	.....	982
Greece	1,555	14,784	30,694
Guatemala[2]	.....	2,094	805
India, British	18,152	15,775	21,922
Japan	12,492	19,897	27,222
New Caledonia	69,429	50,072	55,182
Norway	409	326	42
Rumania	.....	29	.....
Southern Rhodesia	15,692	35,046	72,099
Turkey	55,196	75,379	119,844
Union of South Africa	19,371	34,078	61,357
U.S.S.R. (Russia)	68,000[3]	112,728	129,200
United States	157	857	375
Yugoslavia	43,925	26,248	47,352
Total	306,000	412,000	619,000

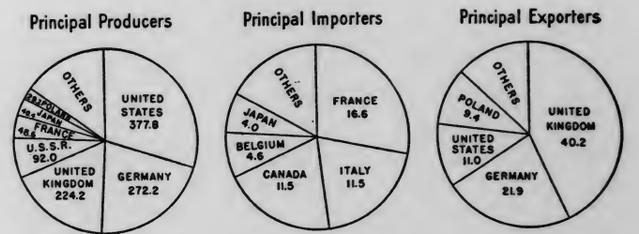
[1] Shipments.
[2] Imports into the United States. The figures for 1934 represent imports for consumption, those for preceding years, general imports.
[3] Approximate production.

CHROMITE—1934



COAL — 1934

(all figures in millions of metric tons.)



Coal is a solid carbonaceous substance, more or less distinctly stratified, that has been formed from the remains of vegetation in consequence of a series of slow changes under varying conditions of moisture, temperature, and pressure, resulting in the loss of water, oxygen, and volatile matter. In the progressive metamorphism of vegetation through geologic processes the first distinctly recognized fuel product is known as *peat*. Peat is the partly carbonized and more or less disintegrated vegetable matter whose decomposition has been arrested by being covered or saturated with water. It is not generally regarded as one of the "ranks" of coal but does represent the lowest stage in the transformation of vegetable matter into coal. Subsequent stages in the metamorphism of vegetable remains as a result of the action of geologic agencies are included in the various ranks of coal that mark the progressive change from lignite to anthracite. The classification of coals by rank is not uniform in all countries. The United States Bureau of Mines has classified domestic coal as shown at the top of page 48.

As used by the United States Geological Survey, the term *lignite* is limited to those coals that are distinctly brown and either woody or claylike in appearance. Lignite is intermediate in quality and in development between peat and sub-bituminous coal. Sub-bituminous coal is the class that generally has been

Class	Group
I. Anthracite	1. Meta-anthracite
	2. Anthracite
	3. Semianthracite
II. Bituminous	1. Low-volatile bituminous coal
	2. Medium-volatile bituminous coal
	3. High-volatile *A* bituminous coal
	4. High-volatile *B* bituminous coal
	5. High-volatile *C* bituminous coal
III. Subbituminous	1. Sub-bituminous *A* coal
	2. Sub-bituminous *B* coal
	3. Sub-bituminous *C* coal
IV. Lignite	1. Lignite
	2. Brown coal

called *black lignite;* it is generally distinguishable from lignite by its black color and the absence of a woody texture and structure. It is distinguishable from bituminous coal by its loss of moisture and the "slacking" that results from alternate wetting and drying. The term *bituminous coal* comprehends a large group with a maximum fuel ratio of about 3. This group includes many of the best coking and gas coals and is only slightly affected chemically by weathering, unless exposed for many years. Semibituminous coal is of a higher rank than bituminous, having a fuel rate of 3 to 6. It has a relatively high percentage of fixed carbon, which makes it nearly smokeless when burned properly. The best of these coals have a heating value greater than that of any of the other ranks. The coal is generally minutely jointed and therefore tender and friable. Semianthracite is a hard coal having a fuel ratio ranging from about 6 to 10 and is neither as hard nor as high in fixed carbon as true anthracite. Anthracite is a hard coal which breaks with a curving fracture and burns with a short, blue flame. It is harder than semianthracite and has a higher percentage of fixed carbon. Its fuel ratio ranges from 10 to not more than 50 or 60.

WORLD PRODUCTION

United States.—The United States is the leading producer of anthracite and bituminous coal, but Germany is the leading producer of lignite. Although the United States contains a far larger amount of high-rank coals than any other country, its reserves of anthracite are relatively small. Coal is mined in 30 States, but virtually all of the anthracite occurs in a small district in northeastern Pennsylvania. Most of the bituminous coals are found in the section east of the Mississippi River and the extensive low-grade lignites chiefly in the northern Great Plains and Gulf provinces. Comparatively little coal is found on the Pacific coast.

Largely for convenience in considering broad questions of geologic age and structure, quality of coal, and transportation, the coal-bearing regions of the United States have been grouped into "provinces." The eastern coal province contains the major part of the high-rank coal of the country and includes the anthracite regions of Pennsylvania and Rhode Island, the Atlantic coast region of Virginia and North Carolina, and all the bituminous and semibituminous coal regions of the vast Appalachian chain.

The anthracite beds of Pennsylvania lie in synclines forming three separate districts with a total area of 480 sq. mi. Much anthracite is now recovered by reworking culm or dump piles at the mines and through the dredging of streams for the coal fines which in earlier years were discharged from the mines as waste.

The Rhode Island anthracite and Atlantic coast regions have little practical importance at present.

The Appalachian coal region, or Appalachian trough, extends from western Pennsylvania and eastern Ohio into eastern Maryland, West Virginia, eastern Kentucky, Tennessee, Georgia, and Alabama. This region embraces an area of 70,000 sq. mi. and is the greatest storehouse of high-rank coal in the United States, if not in the world. These coals are of Carboniferous age. In general, the beds are horizontal and undisturbed in the western part of the region and become progressively more faulted and folded toward the east. The thick, extensive seams in this field are especially notable. Many of these fields are very high grade and are used extensively in the manufacture of gas and coke.

The Interior province includes the bituminous-coal fields of Michigan, Illinois, western Kentucky, Indiana, Iowa, Missouri, Kansas, Oklahoma, and Arkansas. The principal region of this province is the eastern, embracing the coal fields of Indiana, Illinois, and western Kentucky; it is an oval basin 47,000 sq. mi. in area and its coals are of Carboniferous age. The nearly horizontal beds are relatively near the surface and in many places can be mined by stripping. The western region of the province

includes Iowa, Kansas, Missouri, Oklahoma, and Arkansas and has an area of 75,000 sq. mi. The coals are principally bituminous, although some semibituminous coal and semianthracite, as well as lignite, occurs in Arkansas. The seams are essentially flat over the entire field, except that they are locally folded in Arkansas and Oklahoma. The northern region is a shallow basin some 11,000 sq. mi. in extent in the central part of the southern peninsula of Michigan. These coals, which are bituminous, are of low grade and are consumed locally. They lie beneath a considerable cover of glacial deposits. The southwestern region embraces the bituminous-coal fields in Texas. The coals of this province are mined extensively and are widely used for heating and for generating power in the Mississippi Valley and Great Lakes areas.

The Northern Great Plains province includes the coal fields in the Great Plains east of the Forest Range of the Rocky Mountains. The formations are generally flat or but little disturbed. In consequence, the coals are low rank and either lignite or subbituminous, except in a few basins near the mountains where upheaval forms have locally changed the coal to higher rank. The province embraces the lignite areas of North and South Dakota and northeastern Montana, the subbituminous coals of southern Montana, Wyoming, and Colorado, and the bituminous coals of the Great Falls and Lewistown fields of Montana, the Denver region of Colorado, and the Raton Nusa region in southern Colorado and northern New Mexico.

The Rocky Mountain province of 126,000 sq. mi. includes fields in the following states: Colorado, Wyoming, Utah, New Mexico, and Montana. The coals are of Cretaceous and Tertiary age and although all ranks of coal are represented, they are chiefly bituminous and subbituminous. The coal has been exploited largely in fields near a market, except where the coal is of excellent grade. The beds may be horizontal or locally disturbed owing to mountain-making forces and igneous intrusions which have elevated the rank of deposits.

The Pacific Coast province is of Tertiary age and occupies 1,900 sq. mi. in Oregon, California, and Washington. California and Oregon contain small fields of low-rank coal, but little mining has been done there. The fields are widely separated and small. The quality of the coal depends on the degree of alteration, hence

there may be variations within a single field. Some Washington coal is of coking grade. Oil is the dominant source of fuel on the Pacific Coast, and until the supply is depleted the demand for coal will be limited.

The Gulf province coal measures are chiefly of Eocene (early Tertiary) age, and extend from Texas into Arkansas, Louisiana, Mississippi, and Alabama. They have been mined at only a few places in Texas, owing to the competition of near-by coals of higher rank, and of oil and gas.

Canada.—Although the important industrial requirements of the country warrant it, the rigorous climate of Canada has retarded production from the coal deposits available, owing in large part to the fact that the principal population and industrial centers are so located that the high-grade coals from the United States can compete very favorably in the Canadian market. Bituminous coals of Carboniferous age occur in Nova Scotia and New Brunswick. In Alberta and Saskatchewan the lignite fields represent the northerly continuation of the northern Rocky Mountain-Great Plains provinces of the United States. Coals of Cretaceous age and bituminous rank are mined in Alberta, particularly in the region of Crowsnest Pass. In British Columbia coals of Upper Cretaceous age and bituminous rank are mined at a number of localities.

Germany.—Germany, whose coal reserves are the largest in Europe, is the world's second largest producer of coal (including lignite) and the largest producer of lignite. The bituminous coals are of Carboniferous and the lignite of Tertiary or Pleistocene age. There are six bituminous-coal districts in Germany, namely, (1) the Saar (under the control of the League of Nations after the World War and until March 1935. Its deposits are extremely valuable because of their proximity to the iron districts of Germany and France. Since the return of the district to Germany the production of coal has increased); (2) Westphalia and Rhine Province (whose deposits extend into the Netherlands, Belgium, and France); (3) the left or west side of the Rhine whose deposits are extensively faulted, (unlike the undisturbed deposits of the east side of the Rhine); (4) Saxony (whose Lower Carboniferous deposits have been mined for a long time until they are now virtually exhausted, so that the small amount of coal now mined comes from the Upper Carboniferous and Permian

deposits); (5) lower Silesia (coal deposits situated at great depths in a region that has been extensively faulted and disturbed by igneous intrusions, serving to coke the coals. Because of their proximity to the zinc districts these coals are very important industrially); and (6) upper Silesia (whose coal fields are the second in importance in Germany. The deposits are highly folded but little faulted, and are renowned for the number and thickness of the coal seams).

Over half of the German coal output is lignite. The largest lignite deposits are in the central part of Prussia; other beds are mined in the lower Rhine region, Braunschweig-Magdeburg, Lausits, and the east German district of Silesia. Large deposits also occur in Saxony and Thüringia.

United Kingdom.—The United Kingdom is the second largest producer of coal in Europe. The coals are of Carboniferous age and are all of bituminous, semibituminous, and anthracite rank. The coal deposits underlie about one-third of the total area of the United Kingdom. The coal fields represent some 40 detached areas of greatly varying size and are roughly classified into three great groups: (1) the southern fields (including the coal basin of South Wales and the small basins of Bristol, Somerset, and of the Forest of Dean. The anthracite deposits of Great Britain are in the South Wales field, whose high-grade coals have been shipped all over the world); (2) the Midland region (whose series of basins occupies an area exceeding 10,000 sq. mi. and includes the following fields: the Yorkshire basin—the largest English coal basin—the north and south Staffordshire basins, the Leicestershire basin, and the Warwickshire basin. The group also includes the relatively unimportant North Wales, Shropshire, and Forest of Wyre deposits); and (3) the northern coal fields (including the large Durham-Northumberland coal basin, the small Cumberland basin, and the Scottish coal basin).

There are several small coal fields in Ireland, the largest being the Leinster field.

U.S.S.R. (Russia).—The production of coal in the Union of Soviet Socialist Republics has manifested an increase unparalleled among the world's larger coal producers. The coal deposits range from Devonian to Jurassic in age. The Donetz basin of southeastern Ukraine, the principal producing district, is about 25,000 sq. km. in area, well supplied with railroads, and readily

accessible from the Black Sea. Both anthracite and bituminous coal are produced.

Undisturbed lignite deposits of Carboniferous age are situated in a basin in the south and west regions about Moscow. Production from this basin was begun just prior to the World War. The coal, although of low grade, has been developed to form a base for the industrial and chemical industries around Moscow.

Coal measures occur on the western and eastern side of the Ural Mountains in Lower Carboniferous deposits. The western deposits show little faulting or folding but merge gradually with the plains of eastern Russia. The eastern deposits show complicated fault and fold structures. It is in this disturbed eastern district that the anthracites of Egorshino are found. South of the anthracite area, in the vicinity of Bogdanovich, are deposits of coking coals. The deposits of bituminous coal on the western slope occur north of Sverdlovsk in a zone 100 km. long and 3 to 8 km. wide.

Since 1921 the coal deposits of the Pechora River basin of northern Russia have been under investigation. The bituminous coals are of Carboniferous age and may be, in part at least, an extension of the Ural deposits. Northern Russia is poor in coal, and if these deposits can be successfully developed they will greatly aid the industrial development of this region. The rigorous climate is a problem which must be considered when a rail- or water-way system for the transportation of this coal is constructed.

In Kazakstan, especially in the northern and northeastern parts, coals of Paleozoic, Mesozoic, and Tertiary age occur, but the coals of Carboniferous age are the most important. The Karaganda basin is the largest field, but this region has been opened only recently by the construction of a railroad.

The Kuznetsk coal basin in central Siberia, with a productive area of 26,000 sq. km., is one of the greatest coal deposits of the world and the largest in the U.S.S.R. The coals are of Carboniferous, Permian, and Jurassic age. A wide variety ranging from anthracite to cannel coal is found in this region.

There are large deposits of coal in the Tungus Basin of Siberia between the Enisei and the Lena Rivers. These deposits, though known since the eighteenth century, were really first investigated about 1918 and information on them is still meager. The

coals are bituminous and partly lignitic. The age of these deposits as yet is undefined but is commonly assigned to the Permian and Carboniferous periods. The rigorous climate, the shortage of labor, and the great distance from the rivers militate against an early and extensive exploitation of these deposits.

Coal is mined in the Far East in the vicinity of Vladivostok and on the Island of Sakhalin. The Sakhalin deposits are quite extensive and of high rank. These coals are shipped from the port of Zaporozhe, weather conditions permitting.

France.—The coal deposits of France may be divided into five regions, namely (1) fields north of the Ardennes Massif (the Valenciennes area is the most important producer. The coals are of high rank, and some are anthracitic); (2) eastern basins of the Pont-à-Mousson and Ronchamp fields; (3) basins of the Armorican Massif (deposits impure and irregular); (4) deposits of the Central Massif (deposits are small. The St. Étienne deposit is the most important); and (5) small deposits in the Alps and Pyrenees (highly folded and irregular in extent).

France is deficient in supplies of coal, as many of the deposits are small, irregular, and impure. The supplies of coking coal are especially low.

France has Tertiary lignite deposits in the southern and south-eastern parts. The Fuveau Basin contains the largest reserves.

Poland.—Coal deposits in Poland occupy the Polish or Silesian-Kracovian basin and underlie 5,750 sq. km. The deposits extend into Germany and Czechoslovakia. The Polish coals are of Upper Carboniferous age and all are bituminous and occupy a folded and faulted region. Many thick seams are found. A small production of lignite comes almost entirely from the Dabrowa Gorniczo region.

Belgium.—All the Belgian coal deposits are bituminous and of Carboniferous age. There are three fields: (1) the Dinant field (small and unimportant); (2) the Campine field in northern Belgium (known chiefly by borings and not so extensively exploited as yet because of its depth. Its reserves are the largest of the three fields); and (3) the Namur field (seams comparatively thin and deeply buried; in fact, the world's deepest coal mines are found here. The structure of this field is complex, due to folding and faulting).

Czechoslovakia.—The Ostrave-Karvinna coal field of Czechoslovakia represents the southerly continuation of the coal fields of German and Polish Silesia. In addition, there are the coal fields of Kladno and Plzeň. Lignite occurs in northwestern Bohemia.

Netherlands.—High-grade coals of Carboniferous age are mined in the southern and eastern part of the Netherlands.

Spain.—The most important coal deposits of Spain are in the northwestern part of the Provinces of Oviedo and León and in the eastern part in the province of Teruel. There are small deposits of Cretaceous and Tertiary coals of lignitic or subbituminous rank in eastern Spain.

Hungary and Yugoslavia.—The chief coal-producing areas of Hungary and Yugoslavia are the lignite deposits in several small Cretaceous and Tertiary basins. Some bituminous coal is also produced.

Japan.—The Japanese Empire is a large consumer of coal but is none too well provided with commercial deposits, accounting for its interest in coals of the Asiatic mainland. The most important and productive coal fields are in the northern part of the southern Island of Kyushu. This district with 13 fields, produces nearly two-thirds of the Japanese coal output. The coals of early Tertiary age are chiefly bituminous, but some anthracite is mined. Favorable climatic conditions and proximity to the sea have aided in the development of these deposits.

The Ishikari field in the central part of the Island of Hokkaido is another large producer. The mines are well-equipped mechanically. The coals are of bituminous rank and of Tertiary age. Owing to high costs, the other deposits are unworked. Two fields are worked on the Island of Honshu; of these, the Joban field is the larger. The coal is of inferior quality but is fortunate in being conveniently within reach of the large Tokyo market; the Ube field is likewise within easy reach of the Osaka market. The coals are of Tertiary age.

A small amount of coal of Tertiary age is produced in southern Karafuto for local consumption.

Bituminous coal of Tertiary age is mined in northeastern Taiwan (Formosa).

In Chosen, anthracite and bituminous coal of Permo-Triassic, Jurassic, and early Tertiary age are mined. The principal

deposit is that of Jeijo, which is of Permo-Carboniferous age.

China.—There are coal deposits in every province of China, whose resources of this commodity are the largest in the Far East. Two large coal fields, the larger extending through the provinces of Szechwan, Yunnan, Kweichou, Kwangsi, and Hunan and the other through the Province of Shansi, are surrounded by a great number of satellitic fields. The largest mines are those of Fushun in Manchuria, leased by the South Manchuria Railway. The deposits worked are exceptionally thick and are mined by stripping. The coals may be coked after mixture with coals from other districts. Another large coal company is that of the Kailan Mining Administration at Tangshan in Hopeh which is controlled chiefly by British interests. Still other mines are operated west of Peiping, in Shantung, and Kiangsi. The occurrence of coking coals is exceptional, but they are found in the Penhsihu field of Manchuria, the Kaiping coal of Manchuria, the Pei Pao coal of Jehol, and other localities. Considerable quantities of anthracite are available. The lignite resources of China are quite small.

The stratigraphy of the Chinese coal fields is very imperfectly known because the coal-bearing formations merge gradually without unconformities, even in the same basin. In general, physical conditions are not favorable to the mining of Chinese coal, as the deposits are much faulted and folded.

British India.—The coal deposits of India are of Gondwana or Permian and Tertiary age. The former coals, of bituminous rank, occur in Bengal, Bihar and Orissa, Central India, Central Provinces, Hyderabad, and Madras, the Jharia, Bokaro, and Raniganj fields of Bengal being the most important producers. About 98 per cent of the Indian coal comes from these deposits. The remaining small production comes from the Tertiary coals of Assam.

The mining of coal is the greatest industry of India, and the government's interest is shown by the recent studies and publications on Indian coal. Special attention is being given to the development of new outlets for the production, especially that offered by the export markets. The loss of export markets dates from the creation of an embargo during the World War.

Union of South Africa.—In the Union of South Africa coals of bituminous rank occur in Transvaal, Natal, and Orange Free State, in the order of their importance. These coals are of Permian age. Deposits of Cretaceous and Tertiary lignites are small and unimportant. The chief deposit in the Transvaal fields is in the Witbank district. Some coal is mined east of the Witwatersrand and in the Ermelo district. The coal mines of the Orange Free State are situated toward the northern boundary of the Heilbron district. Coal is found in Natal in Klip River County, and in Utrecht, Vryheid, and Paulpietersburg districts.

INDUSTRIAL USES

The importance of coal becomes evident in the light of its preeminent position as a primary source of energy for heat and power. Our modern civilization would not be possible were it not for the elaborate housing and heating arrangements, the comprehensive systems of transportation and communication, and the almost innumerable manufacturing activities of modern communities, all wholly dependent upon the continuance and further development of the metallurgical arts that are based upon the use of coal. Not only are the industries of industrial nations based largely upon the utilization of this energy-producing mineral, but its by-products afford also the basis upon which are founded most of our chemical industries.

Some idea of the importance of coal from a world standpoint may be gleaned from the fact that the world's annual production is normally in the neighborhood of 1,250,000,000 metric tons. Of this amount approximately 22 per cent is used as raw material and 78 per cent as fuel. Of the coal used as raw material, it has been calculated that 10 per cent of the world's production is required in the production of pig iron, 7 per cent in steel production, and 5 per cent in gas works. Of the world's total used as fuel, 29 per cent is utilized for the raising of steam, 23 per cent for railway transportation, 6 per cent for electric generating stations, 3 per cent for water transportation, and 17 per cent for domestic purposes, such as heating.

For the manufacture of coke only coal that will "cake" is suitable. For the manufacture of coal gas a high-volatile coal is required. The presence of sulphur increases the liability of the coal to spontaneous combustion, and more than 1.5 per cent sulphur precludes its use for the manufacture of gas or blast furnace coke. The presence of phosphorus in excess of 0.02 per

cent renders the coal useless in manufacturing iron and steel. The low-volatile semibituminous "smokeless" coals yield the largest number of British thermal units and are best suited for naval use. Anthracite and semianthracite are the best domestic fuels as they are nearly free from sulphur and almost smokeless, though their heating value is less than that of the better grades of bituminous coal. All things being equal, the coal with the greatest number of British thermal units per pound will be the most efficient, but in a particular locality coal of an inferior rank may be cheaper than the more efficient coal by reason of its proximity to the market.

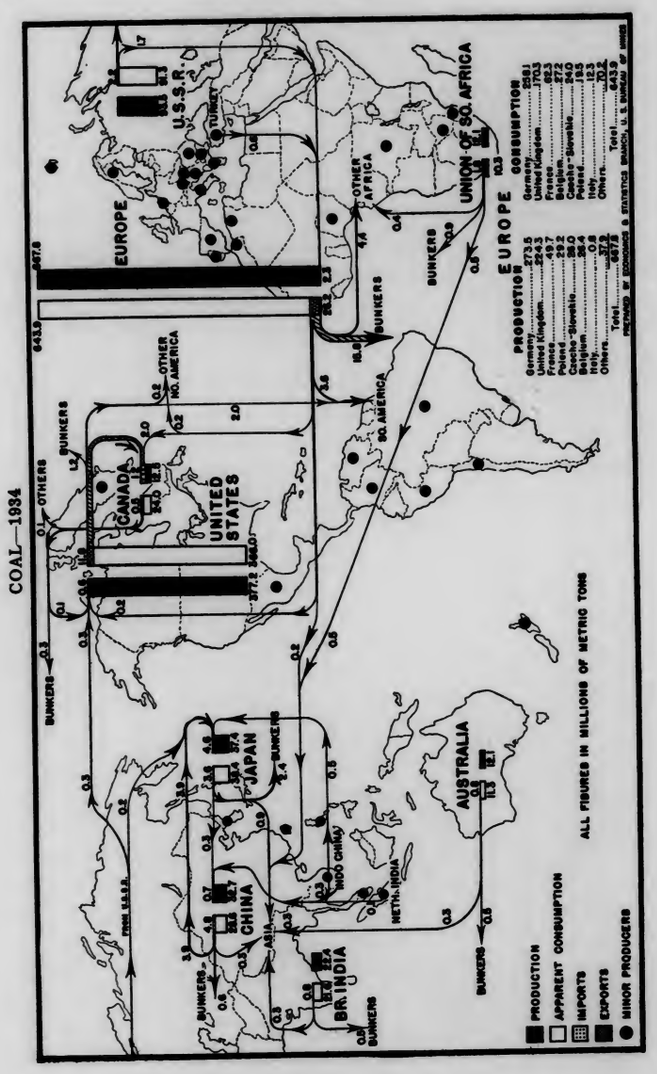
SUBSTITUTES

For many of the industrial uses of coal there are no substitutes. Energy is produced also from petroleum and natural gas and from hydroelectric installations, and these sources of power compete with coal.

WORLD PRODUCTION OF COAL AND LIGNITE IN THE PRINCIPAL COUNTRIES OF THE WORLD, 1932–1934
(In Thousands of Metric Tons)

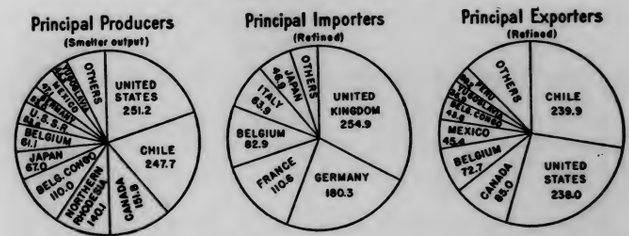
Country	1932	1933	1934
North America:			
Canada: Coal	7,507	8,533	9,613
Lignite	3,142	3,370	2,916
Mexico	687	647	782
United States: Anthracite	45,228	44,943	51,862
Bit. coal & lignite	280,963	302,663	326,011
South America:			
Chile	1,080	1,538	1,808
Europe:			
Austria: Coal	221	239	251
Lignite	3,104	3,014	2,851
Belgium	21,424	25,300	26,389
Bulgaria: Coal	98	80	76
Lignite	1,663	1,493	1,561
Czechoslovakia: Coal	10,961	10,532	10,687
Lignite	15,858	15,063	15,172
France: Coal	46,267	46,887	47,607
Lignite	1,012	1,093	1,031
Germany[1]: Coal	104,741	109,692	124,910
Lignite	122,647	126,794	135,995
Saar[2]	10,438	10,561	11,318
Hungary: Coal	895	800	756
Lignite	5,931	5,907	6,199
Italy: Coal	255	334	295
Lignite	376	383	409
Netherlands: Coal	12,756	12,574	12,341
Lignite	124	97	92
Poland: Coal	28,835	27,356	29,233
Lignite	33	33	26
Rumania: Coal	188	195	228
Lignite	1,464	1,314	1,624
Spain: Coal	6,854	5,999	5,932
Lignite	336	301	299
U.S.S.R. (Russia)	53,600	66,000	71,268
United Kingdom	212,083	210,436	224,270
Yugoslavia: Coal	368	379	387
Lignite	4,107	3,777	3,926
Asia:			
China	28,000[3]	[4]	[4]
Chosen	1,104	1,307	1,689
India, British	20,477	20,107	22,411
Indo-China: Coal	1,691	1,591	1,592
Lignite	23	.....	.....
Japan: Japan proper: Coal	27,774	32,153	35,925
Lignite	109	116	125
Karafuto	688	889	1,197
Taiwan	1,355	1,533	1,521
Netherland India	1,050	1,035	1,032
Turkey: Coal	1,594	1,860	1,652
Lignite	14	30	51
U.S.S.R. (Russia) Sakhalin	10,400	10,700	20,763
Africa:			
Union of South Africa	9,921	10,714	12,195
Oceania:			
Australia: New South Wales	6,893	7,233	8,000
Queensland	855	890	972
Victoria: Coal	439	531	363
Lignite	2,654	2,621	2,660
New Zealand: Coal	943	857	845
Lignite	928	993	1,248
Other countries[5]	2,920	3,189	3,769
Total	1,125,000	1,174,000	1,275,000

[1] Exclusive of the mines in the Saar, which were under French control.
[2] Mines under French control.
[3] Approximate production.
[4] Estimate included in total.
[5] Other countries: Albania, Algeria, Belgian Congo, Brazil, Federated Malay States, French Morocco, Greece, Greenland, Iran, Irish Free State, Nigeria, Northern Ireland, Peru, Philippine Islands, Portuguese East Africa, Southern Rhodesia, Svalbard (Spitsbergen), Sweden, Switzerland, Tasmania, Venezuela, and Western Australia.



COPPER — 1934

(all figures in thousands of metric tons.)



Copper[1] is the most abundant and most important of the base metals. Its commercial ores may contain any of the following minerals: Native copper (Cu), cuprite (Cu_2O), chalcocite (Cu_2S), covellite (CuS), bornite (Cu_5FeS_4), malachite ($2CuO.Co_2.H_2O$), azurite ($3CuO.2CO_2.H_2O$), enargite (Cu_3AsS_4), chrysocolla ($CuO.SiO_2.2H_2O$), and chalcopyrite ($CuFeS_2$). Copper deposits consist of the four following mineralogical types: (1) native copper ores; (2) oxidized ores which may run 20 to 25 per cent copper or be very low grade; (3) sulphide-enriched ores composed of chalcocite, covellite, and so on; and (4) sulphide ores occurring in masses or veins and composed of chalcopyrite, bornite, enargite, and similar copper-bearing minerals. Gangue minerals accompanying copper-bearing minerals are quartz, calcite, dolomite, barite, siderite, pyrite, iron oxides, and feldspar. Other metals, such as zinc, silver, gold, arsenic, antimony, bismuth, and tellurium, are impurities which are removed by electrolytic refining. The average tenor of ores mined has decreased steadily from about 20 per cent down to about 1.5 per cent during the period 1851 to 1935.

Copper deposits may be classified by modes of occurrence as follows: (1) vein or fissure deposits (typical deposits at Butte,

[1] Symposium, Copper resources of the world, XVIth International Geological Congress, Washington, 1935, 2 vols., 855 pp., ill.

Mont.); (2) disseminated deposits, (*a*) disseminated native copper deposits in sediments and lavas of the Lake Superior type; (*b*) disseminated sulphides in porphyry and schists, as in Bingham Canyon, Utah, and Morenci-Metcalf, Ariz., respectively, and (*c*) sulphides and oxides of copper in sandstones (red beds); (3) lenticular sulphide deposits in schist, as in Ducktown, Tenn.; and (4) replacement deposits in limestones near centers of volcanic activity, such as those of Bisbee, Ariz.

Although copper is widely distributed over the world there are but four principal provinces of supply: (1) the Rocky Mountain and Great Basin area of the United States; (2) the Pre-Cambrian shield of northern Michigan and Canada; (3) the western slopes of the Andes Mountains of Peru and Chile; and (4) the Central African plateau of Northern Rhodesia and Belgian Congo.

Modern excavating machinery, similar to that employed in the great iron ranges of the Lake Superior District and using cheap fuels or electricity, is extensively used in open-cut copper mining. Most of the open cuts are terraced and have a railway on each terrace; the ore is mined by steam or electric shovels and loaded into cars.

Low-grade copper ores are concentrated by gravity as well as by the flotation process. The leaching method allows water to percolate through the ores, the copper being removed as copper sulphate and precipitated on scrap iron as metallic copper.

Smelting practice follows the general furnace method of reducing this metal to form a matte containing 35 to 50 per cent copper. The matte is treated in a converter to remove the iron and sulphur as slags. The slag is poured off, and the copper is cast into various types of pigs, bars, and other shapes. An ingot in this form is known as blister copper and contains 96 to 99.9 per cent copper; the remainder consists of other metals. The copper anodes are taken to an electrolytic refinery where the copper is purified and the valuable impurities, such as gold, silver, nickel, and antimony, are collected in the slimes and refined.

The discovery and bringing into production of new copper deposits are continuing. Some of the new deposits that have recently been developed are as follows: Northern Rhodesia; Katanga; Frood copper-nickel deposit, Sudbury, Ontario;

Noranda district, Quebec; and Flin Flon and Sheritt-Gordon mines, Manitoba.

PRINCIPAL DEPOSITS

United States.—The United States is the world's largest producer of copper. In 1934, however, Chile surpassed the ore production of the United States. Three provinces or sections are the most important sources of copper in the United States. The western section (the most important of these three provinces), includes the principal producing states: Arizona, Montana, Utah, and Nevada. Other states in this section that produce copper are California, Colorado, Idaho, New Mexico, Oregon, and Washington. The northern peninsula of Michigan is the second most important section for copper. Unlike the other districts, the copper occurs here in its native state. Some copper is produced in eastern Tennessee and adjoining states. There are twelve electrolytic refineries in the United States; five on the Atlantic, three on the Great Lakes, and four west of the Great Lakes. Two of them have been idle since 1933. The refineries on the east coast do a large business in smelting and refining foreign ores and metal.

Copper is also obtained from secondary sources. This industry has held up better during the depression than has production of primary copper.

Chile.—Chile is the world's second largest producer of copper, containing as it does three important copper properties, all controlled by United States capital: (1) the Braden copper deposit south of Santiago, situated near a great volcanic vent (The ore occurs here as chalcopyrite, bornite, and tennantite, with enriched ores of chalcocite. Nowhere is the genesis of copper ores from magmatic or volcanic sources more clearly shown than at Braden); (2) the Chuquicamata deposit of northern Chile in the Province of Antofagasta, the largest copper mine in the world; and (3) the Potrerillos deposit of the Atacama Province, situated in the midst of the barren Atacama Desert. Three ore bodies are known to occur in an altered and fractured porphyry. The primary ores consist of pyrite, chalcopyrite, and enargite. In the oxidized zone are found chrysocolla, azurite, malachite, tenorite, melaconite, brochantite, cuprite, and native copper. Chalcocite, covellite, and bornite are present in the enriched zone. The sulphide ore carries about 1.4 per cent copper.

Canada.—The Province of Ontario is by far the leading producer of copper in Canada. The output is derived entirely from the nickel-copper ores of the Sudbury district. The Province of Quebec, which is next in the order of production, has two active producers, the Noranda Co. in northwestern Quebec and the Eustis mine of the Consolidated Smelting & Refining Co. in the Eastern Townships. The concentrates from the latter property are shipped to smelters in the United States. The production of copper from British Columbia comes from the Britannia mine on Howe Sound. Its concentrates are shipped to Tacoma, Wash., for smelting. Production in Manitoba and Saskatchewan comes entirely from the Flin Flon mine, which is on the boundary of the two provinces. Blister copper is shipped to Montreal for refining.

Northern Rhodesia.—The Northern Rhodesia copper belt is a strip 140 miles wide adjoining the Katanga boundary of the Belgian Congo. The region is far inland but is now being made accessible by railway. There are eight commercial deposits operating as three units—the Roan Antelope, Rhokana, and Mufulira. The deposits are tabular and consist of sediments containing sulphide ore, which may be oxidized, as is the case in some localities. In many general ways the deposits resemble the porphyry coppers, although they are bedded deposits. The tenor of the ore ranges from 3.5 to 7.9 per cent.

Belgian Congo.—The copper belt of the Belgian Congo is about 60 miles wide and 160 miles long. This zone represents a continuation of the copper belt of Northern Rhodesia. Some 16 deposits are known in Katanga. These deposits show the same bedded character as those of Northern Rhodesia, but their relation to neighboring igneous rocks is less clear. In these deposits the copper is associated with cobalt- and uranium-bearing minerals.

Japan.—Copper deposits are widely distributed in Japan, and some 110 mines were in operation in 1932.[2] The deposits are of three types: (1) and (2) Contact replacement deposits in Paleozoic sediments of the southern extremity of the Island of Honshu and the adjoining northern Kyushu Island. These replacement

[2] KANEHARA, N., Copper resources of the world, XVIth International Geological Congress, Washington, 1935, p. 688.

deposits are of two types: (1) a lenticular or tabular deposit of cupriferous pyrite in schists on the Island of Shikoku and (2) the less abundant "black-ore" deposits composed of galena, sphalerite, and barite with chalcopyrite. These latter deposits are found in the lavas and tuffs of northern Honshu. (3) Fissure-vein deposits. About 70 mines are working deposits of this type. The ore consists of chalcopyrite and pyrite, or pyrrhotite. These veins may be classified further according to the associated minerals. Veins of this type occur in the interior of southern and northern Japan. The fissure and "black-ore" deposits are the most important in Japan. Copper production expanded greatly during the World War, but subsequently decreased as a matter of national policy of conserving native ores and using foreign instead.

Mexico.—The largest copper deposits in Mexico are in the State of Sonora 60 miles south of Nogales, Ariz., near the United States boundary. The most important mining district is the Greene-Cananea. These deposits are controlled by American capital. A deposit in this region worthy of note is that of the Pilares de Nacozari.

In Lower California, on the Gulf side, is the El Boleo copper mine. This property has been in production for many years and is operated by a French company. The ore occurs in Tertiary sediments.

Spain.—Copper is mined in Spain in the Huelva and Badajoz districts. The Huelva district is by far the larger and is controlled commercially by the British. The ore occurs as massive cupriferous pyrite, and some of the largest sulphide ore bodies in the world have been developed in these districts. The mines are equipped to produce approximately 3,000,000 tons of ore annually. Pyrite ore is also produced and is used for the manufacture of sulphuric acid.

U.S.S.R. (Russia).—The Ural region, which has been more intensively prospected than other copper districts of the Union of Socialist Soviet Republics, contains the most important producing mines. The copper occurs as cupriferous pyrites in schists. Deposits of a similar character occur in the Caucasus region. Very large deposits of porphyry copper are being developed in central Kazakstan in the Lake Balkhash region. A

smelter is being erected to treat these ores, and a railway to the deposits is under construction. Copper-impregnated sandstones occur extensively in the Djeskasgan district.

Deposits of less importance occur in the Kola Peninsula, Karelia, Novaya Zemlya, in the Minusinsk, Enisei-Norilsk, and Lena districts of Siberia, and in the Far East. None of these districts is producing at present. The copper industry of Russia is quite old, and for some time this country was the leading producer of copper. Until the World War the industry was largely controlled commercially by the British. At present every effort is being made to attain a position of self-sufficiency with respect to copper.

Yugoslavia.—The Mines de Bor copper company of southeastern Yugoslavia is the sole producer of copper metal in this country. It is reported that the capacity of the plant is being increased to 5,000 tons of copper per month. The United States refines a large part of the product.

Germany.—The Mansfeld copper deposits of central Germany are the principal source of German copper. A much smaller production of copper is mined from the Rammelsberg pyrite deposits near Goslar in Hannover. The Mansfeld ores occur in a copper-bearing horizon 20 m. thick in the Permian shales. The ores, averaging 3 per cent copper and containing a little silver, are smelted at Hettstedt. The Mansfeld Company has been producing copper for more than 250 years. Owing to the low tenor of the ore and to the world price of copper, the production of the Mansfeld Company has been subsidized by the German Government during the last 10 years. The Rammelsberg ores contain lead, zinc, and copper and are smelted at Oker.

Peru.—The Cerro de Pasco and Morococha copper districts are about 70 miles apart in the high Andes of Central Peru. The deposits are controlled by American capital. The ores are of a complex character and contain some lead, silver, and gold, as well as copper. Operating conditions are rather rigorous at the prevailing high altitudes at which these districts are situated. On the west side of the Cordillera Occidentale is the old Quiruvilca district, in a rugged mountainous country. The ores of this area are complex and contain some gold and silver.

Norway.—The copper deposits of Norway consist of cupriferous pyrite and pyrrhotite in the central mountain chain. The most

important deposits are those of Lökken, Sulitjelma, Foldal, Röros, and Viganes.

Australia.—Tasmania is the largest Australian producer of copper ore, followed by Queensland. In Tasmania the Mount Lyell district has the largest output, and the ores are treated at Queenstown. Copper has been produced at a number of localities in Queensland, but most of these mines are now closed. The Mount Morgan district on the eastern coast is the outstanding producer of copper ore in Queensland.

India.—Mixed copper ore is found in India in the Northern Shan States and is mined at the Bawdwin silver-lead-zinc mine of the Burma Corporation. Smaller copper deposits are worked in the Singhbhum district of Bihar and Orissa.

Other Countries.—There are copper mines of some commercial importance in Cyprus, Finland, France, Hungary, Italy, Newfoundland, Rumania, Sweden, and the Union of South Africa. Some copper is smelted in Austria, Chosen, Czechoslovakia, France, Italy, Rumania, Sweden, Union of South Africa, and the United Kingdom.

Belgium and the United Kingdom produce no copper. Ores and concentrates are, however, shipped to these countries for smelting and refining.

INDUSTRIAL USES

Of the manifold uses of this metal, the electrical industries require the largest proportion of the world supply. The importance of copper in the manufacture of electrical goods can be appreciated when thought is given to the adaptation of this metal as an essential constituent of equipment that enters so intimately into our everyday life. It is an outstanding factor in the transformation and distribution of power generated from such energy-producing minerals as coal, petroleum, natural gas, and water. Outstanding equipment manufactured from copper includes generators, motors, electrical locomotives, and switchboards. Electrical systems relied upon copper for transmitting communications prior to utilization of the radio.

Metallic copper in the form of wire, brasses, and bronzes is required for the manufacture of starters and generational and ignition equipment for automobiles. Motor transportation annually requires a comparatively large tonnage of copper.

Light and power lines, wire cloth, rods and wire manufactured from copper indicate some of the essential uses of this metal.

In the building trades and in the manufacture of ammunition, castings, copper-bearing steels, radiators, radio receiving sets, refrigerators, ships, and household gadgets, some of the services now supplied by this metal are indicated.

Copper comprises over one-third of the metals used in the nonferrous-alloy industries.

SUBSTITUTES

During the World War, Germany was forced to substitute other metals for copper. Aluminum, and to a smaller degree, zinc, replaced in part some of the essential uses.

Until a few years ago the position of copper in the electrical industry was considered impregnable. However, during the last 15 years aluminum has to some extent replaced copper in high-tension transmission work, particularly in France, Germany and Switzerland—countries in which there is a deficiency of copper and oftentimes a lack of exchange with which to purchase it.

References

CHAPMAN, T. G.: Concentration of copper ores in North America, *U. S. Bur. Mines, Bull.* 392, 1936, 169 pp.

PARSONS, A. B.: The porphyry coppers, A.I.M.E., 1933, 581 pp.

RIDDELL, G. C., and G. D. JERMAIN: Russian copper, *Eng. Mining J.*, vol. 136, No. 12, December, 1934, pp. 547–551; February 1935, vol. 136, No. 2, pp. 82–87.

Symposium, Copper metallurgy, *Trans. A.I.M.E.*, vol. 106, 1933, 740 pp.

WILLIAMS, D.: The geology of the Rio Tinto mines, Spain, *Inst. Mining Met.*, London, *Bull.* 355, ill., April 1934, 48 pp.

WORLD MINE PRODUCTION OF COPPER, 1932–1934
(In Metric Tons)

Country	1932	1933	1934
Algeria	18	17	140
Australia	14,893	14,644	12,205
Austria	171	133	83
Belgian Congo[1]	54,000[2]	66,596	110,085
Bolivia[3]	2,017	1,849	1,622
Bulgaria	2	.....	4
Canada	112,345	136,069	165,452
Chile	103,173	163,395	254,863
China[4]	16	36	[5]
Cuba	5,927	8,957	6,192
Cyprus	3,300	4,300	5,100
Finland	6,649	11,362	10,123
France	435	226	[6]
French Equatorial Africa	150	[6]	[6]
Germany	30,741	29,434	25,970
Greece	.....	2	131
Hungary	278	315	228
India, British	11,400	10,900	11,700
Italy	381	329	394
Japan:			
Japan proper[1]	71,877	69,033	67,778
Chosen[1]	694	785	1,434
Taiwan	4,417	4,000[7]	4,000
Mexico	35,213	39,825	44,268
Newfoundland	2,153	3,162	3,859
Norway	16,944	19,879	21,122
Peru	22,890	24,874	27,735
Portugal[7]	2,000	2,000	2,000
Rhodesia:			
Northern Rhodesia	88,639	131,500	160,128
Southern Rhodesia[1]	6	.....	.....
Rumania[1]	109	453	202
South-west Africa[3]	2,400	.....	.....
Spain	35,000	44,000	30,000
Sweden	4,309	6,871	5,099
Union of South Africa	9,403	8,383	7,862
U.S.S.R. (Russia)	32,000	32,700	44,100
United Kingdom	62	41	14
United States	216,010	172,948	215,369
Yugoslavia	18,946	35,304	43,000
Total	909,000	1,045,000	1,282,000

[1] Smelter product.
[2] Fine copper content of smelter product.
[3] Copper content of exports.
[4] Exports of ingots and slabs.
[5] Less than one-half ton.
[6] Data not available; estimate included in total.
[7] Approximate production.
[8] Year ended Mar. 31 of year following that stated.

WORLD SMELTER PRODUCTION OF COPPER, 1932–1934
(In Metric Tons)

Country	1932	1933	1934
Australia	13,521	11,418	8,098
Austria	1,987	1,000	597
Belgian Congo	54,000[1]	66,596	110,085
Belgium[2]	26,950	35,360	61,110
Canada[3]	95,710	118,109	151,818
Chile	97,517	157,232	247,721
China[4]	16	36	[5]
Chosen	694	785	1,434
Czechoslovakia	936	779	633
France	995	710	1,000
Germany[6]	50,900	49,800	53,000
India, British	4,514	4,900	6,400
Italy	427	120	303
Japan	71,877	69,033	67,002
Mexico	34,000[7]	39,600	47,100
Norway	5,416	6,694	7,989
Peru	22,531	24,679	28,033
Rhodesia:			
Northern Rhodesia	68,977	105,877	140,110
Southern Rhodesia	6	.....	.....
Rumania[8]	109	453	202
Spain	15,555	17,268	13,777
Sweden[9]	3,138	6,638	7,854
Union of South Africa	9,387	8,378	8,328
U.S.S.R. (Russia)[10]	46,600	45,300	53,600
United Kingdom	13,000	11,300	11,380
United States[11]	278,997	227,223	251,225
Yugoslavia	30,159	40,318	44,390
Total	948,000	1,050,000	1,323,000

[1] Copper content of blister copper produced.

[2] Figures represent blister copper only. In addition to blister copper, Belgium reports a large output of refined copper which is not included above as it is believed produced principally from crude copper from the Belgian Congo and would, therefore, duplicate output reported under the latter country.

[3] Copper content of blister copper produced.

[4] Exports of ingots and slabs.

[5] Less than 1 ton.

[6] Exclusive of material from scrap (Metallgesellschaft, Stat. Zusammenstell.).

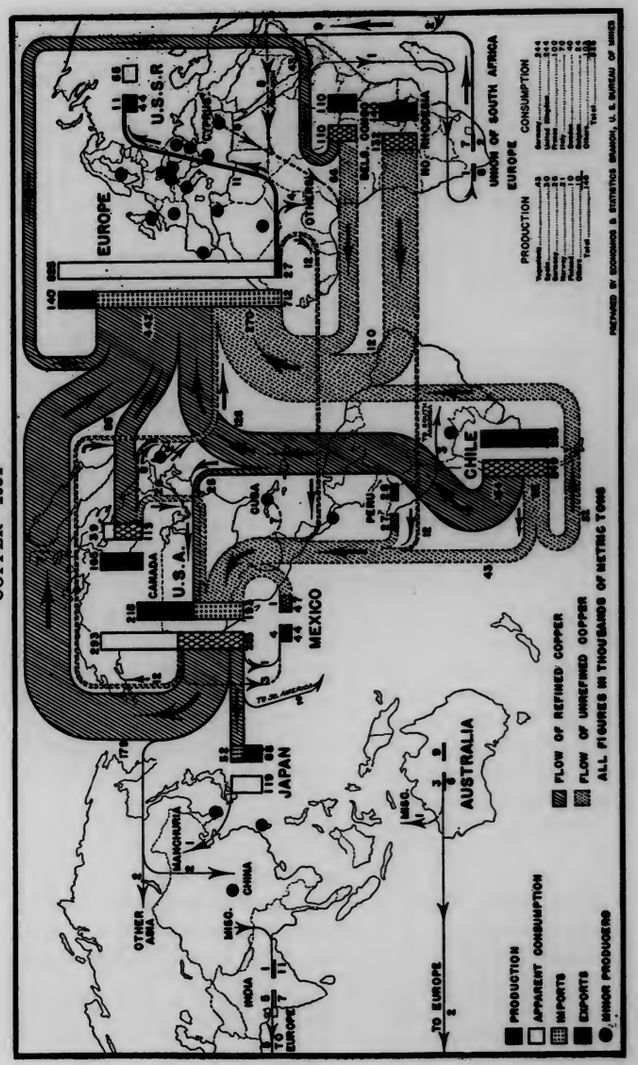
[7] Approximate production.

[8] Smelter output from ores.

[9] Exclusive of material from scrap.

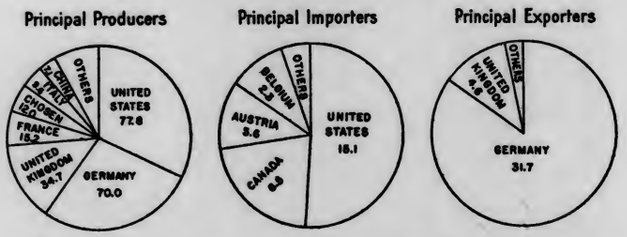
[10] Figures probably include secondary material.

[11] Smelter output from domestic and foreign ores, exclusive of scrap. The production from domestic ore only, exclusive of scrap, was as follows: 1932, 246,759 tons; 1933, 204,115 tons; 1934, 221,558 tons.



FLUORSPAR — 1934

(all figures in thousands of metric tons.)



Fluorspar[1] or fluorite is calcium fluoride (CaF_2), a low-temperature mineral derived from deep-seated magmatic emanations. Fluorite is often very pure but may be associated with barite and calcite and sulphides of lead and zinc. It is distributed widely over the earth and has wide geological range.

WORLD PRODUCTION

United States.—The United States is the world's chief producer of fluorspar, the largest part of which is obtained from the deposits of western Kentucky and the adjoining portions of southern Illinois. Deposits in Colorado occur in a belt that parallels the east side of the Front Range; several deposits are also found in the southern and southwestern part of the State. Fluorspar is produced from mines in the vicinity of Deming, Luna County, New Mex.

Germany.—Germany is the second largest producer of fluorspar in the world. Commercial deposits are found in the Harz Mountains, upper Palatinate, Thüringian Forest, and Black Forest. The highest grade ore is that in the upper Palatinate. Rich veins, cheap labor, efficient mining practice, and standardization of the product, as well as an excellent near-by market

[1] MENDENBACH, F. K., Vorkommen, Gewinnung, Verarbeitung, und wirtschaftliche Bedeutung des Flusspates, Thesis, Berlin Hochschule, Wetzlar, 1933, 248 pp.

have served to develop the industry. Many of these mines were originally worked for silver-bearing galena.

United Kingdom.—Fluorspar occurs in England, associated with the lead and zinc veins of Derbyshire and Durham.

Chosen.—Little authentic information is available either as to the size or character of the deposits.

Italy.—Fluorite deposits are located in southern Tirol or Trento, north of Serentino, but they were not developed until shortly after the World War.

Spain.—Fluorspar is produced in Spain in the Province of Gerona and is chiefly a by-product of lead mining. Other deposits have been exploited in Oviedo, Barcelona, and Viscaya Provinces.

France.—Fluorspar is found in the Central Massif, Lyonnais and Provence regions of France. The deposits of the Central Massif in the Department of Var are the most important.

Newfoundland.—Newfoundland is a comparatively new producer, but there are deposits in Burin East and Burin West near East St. Lawrence. The occurrences are large and near tidewater.

Union of South Africa.—Fluorspar is produced in the Zeerust district of Transvaal, Union of South Africa.

INDUSTRIAL USES

By far the largest part of the world production of fluorite is utilized as a flux in the manufacture of steel. It may be said that from a metallurgical standpoint this use is a commercial convenience rather than an absolute necessity.

The basic open-hearth process for the production of steel utilizes 8 to 10 lb. of fluorspar per ton of steel output. The spar is added to the bath just before the furnace is tapped to render the slag more fluid as well as to desulphurize, in part, the molten metal.

High-grade fluorspar is required in the production of aluminum. The spar is fused with bauxite and soda ash, forming an artificial cryolite, sodium-aluminum fluoride. This artificial mineral is used as a molten bath in the electrolytic process of aluminum manufacture.

For the production of certain enamels, fluorspar is employed. It is required in the manufacture of glass to produce opalescence. In the preservation of wood, sodium fluoride is said to be superior to other chemicals, but as the price of zinc chloride usually is

about half that of sodium fluoride and as this chemical may be used for the same purpose, the consumption of fluorine in this industry is limited.

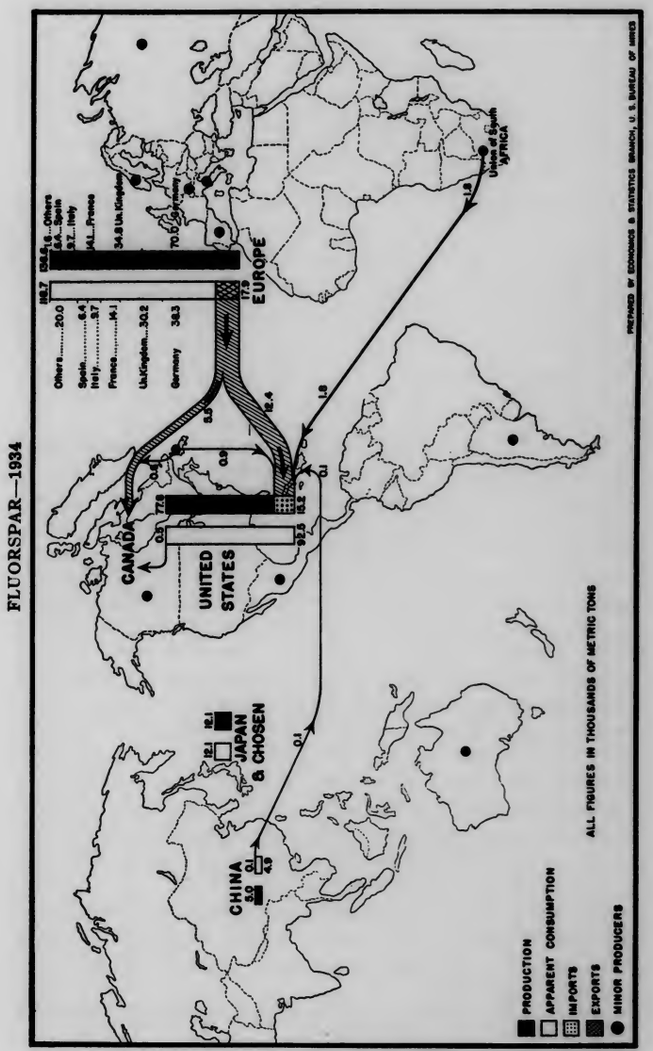
Reference

LADOO, R. B.: Fluorspar, its mining, milling, and utilization, with a chapter on cryolite, *U. S. Bur. Mines, Bull.* 244, 1927, 185 pp.

WORLD PRODUCTION OF FLUORSPAR, 1932–1934
(In Metric Tons)

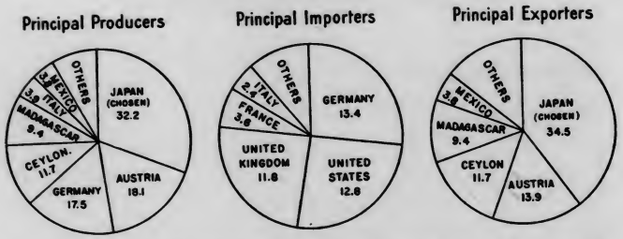
Country[1]	1932	1933	1934
Argentina[2]	10	200	311
Australia:			
New South Wales	.....	51	203
Queensland	1,240	749	1,328
South Australia	41	201	234
Canada	29	66	136
China[3]	7,100	7,100	7,100
Chosen	7,577	9,076	12,099
France	15,200	[4]	[4]
Germany:			
Anhalt	[4]	[4]	7,357
Baden	[4]	[4]	6,527
Bavaria	21,915	26,364	29,661
Prussia	7,794	10,653	21,555
Saxony	2,656	3,672	4,945
Italy	6,450	7,714	9,668
Mexico[3]	900	900	900
Newfoundland (shipments)	.....	1,451	2,535
Norway	571	507	673
South-West Africa	610	.....	.....
Spain	7,018	3,564	6,365
Switzerland[3]	1,000	1,000	1,000
Union of South Africa (sales)	1,317	445	1,393
United Kingdom	15,675	28,508	34,765
United States (shipments)	22,907	66,161	77,823

[1] In addition to countries listed, U.S.S.R. (Russia) produces fluorspar, but data of output are not available.
[2] Railway shipments.
[3] Estimated annual output.
[4] Data not available.



GRAPHITE — 1934

(all figures in thousands of metric tons.)



Graphite[1] is the element carbon. Natural graphite may be either crystalline or amorphous. The term *crystalline graphite* commonly means graphite in crystals large enough to be seen with the eye; much of the so-called amorphous graphite shows crystalline structure under the microscope.

Amorphous graphite may occur wherever coal or other carbonaceous beds have been metamorphosed. Crystalline graphite occurs either as flakes in schist or as larger crystals in veins. Flake graphite occurs in schist that is associated with intrusive granitic rock, the intrusions apparently having converted the carbonaceous material in the schist to crystalline graphite. Vein graphite is generally associated with intrusive granitic rocks and with sediments containing flake graphite. The graphitic schist mined in the United States contains from 3 to 12 per cent of graphitic carbon. The carbon content of minable deposits of amorphous graphite may range from 30 to 80 per cent.

Ores containing such mineral impurities as mica, chlorite, and pyrite are not as a rule commercial.

Mining is largely carried on in small open pits. Underground mines are generally worked by room-and-pillar methods. Prior

[1] Stutzer, O., Die wichtigsten Lagerstätten der "Nicht-Erze," Berlin, vol. 5, 1933, pp. 98–202.

Tyler, P. M., Graphite, *U. S. Bur. Mines, Inf. Circ.* 6118, April 1929, 45 pp.; *Inf. Circ.* 6122, May 1929, 25 pp.

to the introduction of oil flotation, milling problems were most difficult to solve. The flotation process introduced since the World War has enabled lower grade deposits to be utilized. The principal methods used for concentrating flake graphite are water flotation, oil flotation, electrostatic separation, and dry concentration. Vein graphite is sorted by hand and concentrated by simple, mechanical methods. Amorphous graphite is concentrated by fine crushing and air flotation.

PRINCIPAL DEPOSITS

Chosen.—Amorphous graphite occurs in beds and lenses in the eastern part of Chosen. American capital has aided in the exploitation of these deposits. Most of the output is exported to Japan. Crystalline graphite occurs in northern Chosen but is of poor quality, and the production has been intermittent. Chosen, one of the few countries maintaining normal output after 1929, became the world's largest producer in 1933.

Germany.—Germany was the world's largest producer of graphite until 1933, when its output was exceeded by both Chosen and Austria. The source of German graphite is the Passau district in eastern Bavaria, a continuation of the Austrian and Czechoslovak mineralization. Near by is the famous Klingenberg deposit, which supplies the best clay for use in the manufacture of crucibles. The graphite occurs as flakes in weathered gneiss and schist.

Austria.—Important deposits of graphite are found in the Alps of Styria, Austria, in intensely folded slates and limestones. The ore runs 40 to 95 per cent carbon and needs only hand sorting. There are smaller deposits in Lower Austria.

Ceylon.—Commercial graphite deposits are situated in the western and southern provinces of Ceylon. The graphite occurs as veins in the fracture planes of the country rock and is won either by open-pit or underground workings. In this wet region deeper workings tend to increase the costs. Cheap hand labor is employed in mining and preparing the ore. Since the World War the industry has been depressed, and from 1930 to 1934 nearly all of the mines were closed. The year 1935 witnessed greater activity than was evidenced for many years. Efforts have been made to form a Plumbago Exchange to promote direct

dealing between the producer and consumer. Recent reports note a proposal for a cartel agreement wth Madagascar.

Madagascar.—Graphite is found in Madagascar over a wide area in graphitic gneisses and schists, ore occurring in weathered seams like coal. It is easily won, and the content of the ore averages 10 to 12 per cent. Generally the ore is worked in open cuts. Formerly the quality of the product varied widely, but the French Government has established and maintained a standard of 85 per cent graphite for the concentrated marketable product. Transportation difficulties due to an inadequate number of roads and the cost of maintaining those in existence are the principal handicaps to the industry. The Maskar Co., a subsidiary of the Morgan Crucible Co. of London, England, is the leading graphite company in Madagascar.

Italy.—Amorphous graphite deposits derived from altered coal or other carbonaceous beds occur in the provinces of Torino, Genoa, Savona, and Cuneo in northern Italy. The provinces of Torino and Savona are the principal sources of graphite.

Mexico.—Amorphous graphite is mined in Mexico at the Santa Maria mine near Hermosillo, Sonora. The graphite occurs in what were originally coal beds, which have been metamorphosed by the intrusion of a granite. The entire output is shipped to Saginaw, Mich.

Norway.—All of the graphite production credited to Norway comes from Skaland in the Nordland district.

Czechoslovakia.—The graphite deposits of Czechoslovakia are situated in Bohemia and Moravia. Both districts produce amorphous graphite, but Bohemia produces a little crystalline graphite.

Canada.—The chief source of graphite in Canada is the Black Donald mine, Renfrew County, Ont. The graphite content of the limestone ranges from 40 to 80 per cent.

United States.—In the United States, amorphous graphite is produced in Colorado, Michigan, Nevada, Rhode Island, New Mexico, and Wisconsin. As far as is known, vein graphite occurs only in Montana. The principal deposits of crystalline flake graphite are in Alabama, California, New Jersey, New York, Pennsylvania, Texas, and Virginia. Artificial graphite is manufactured at Niagara Falls.

U.S.S.R. (Russia).—Graphite is produced in the Union of Socialist Soviet Republics from the Alibert mine near Irkutsk

and in the Turukhansk region near the Enisei River in Siberia. Because of ice, this river is only navigable for a short time during the summer. Part of the Siberian material is lump graphite similar to the vein graphite of Ceylon, but most of it is amorphous. Deposits in the Ural Mountains have been operated for several years. Factories for the manufacture of graphite products are located at Kyshtim in the Urals and at Mariupol in the Ukraine. A new plant has recently been constructed in the Gruzhkov region near Odessa.

Other Countries.—Small amounts are produced in Australia, British India, Japan, French Morocco, and the Union of South Africa.

INDUSTRIAL USES

Graphite, known as plumbago in the trade, occurs in nature in two forms, crystalline and amorphous. Each has its distinct uses. Crucibles employed in the refining and reduction of gold and silver are made from the crystalline form of graphite. For this use graphite is believed to be indispensable. Crucibles of this type are also used by the steel and brass industry. The amorphous type of graphite is used as a facing for castings, as well as in ingot molds, to prevent the metal when cool from adhering to the sides of the forms. By far the largest part of the world's consumption of graphite is in foundary facings and core wash. The advantage of using graphite in metal castings is that it can be readily smoothed, thus giving a good surface to the mold. When the molten metal is properly poured into the form a film of gas is generated, preventing adhesion to the sand or to the mold.

The next largest application is as a lubricant. Pulverized graphite of all types is extensively used in the preparation of various forms of lubricants. Abrasive impurities, such as silica, must be entirely absent. As a rule graphite is mixed with grease when used for this purpose.

In the manufacture of pencils the mixture employed is composed largely of graphite. Typically the lead in lead pencils contains 30 parts graphite, 9 parts clay, 9 parts antimony sulphide (stibnite), and 1 part tallow. While this use is a very important one, the amount of graphite so consumed throughout the world probably does not exceed 4,000 tons a year.

Graphite is used extensively in paints for the protection of metal surfaces, such as smoke tanks, roofs, bridges, and pipes, against the corroding action of smoke and various gases. It is also used to prevent the formation of boiler scale, as fillers for dry batteries, in stove polish, glaze, and polish for powder and shot, and in various forms of steam packing. An important use that consumes a relatively small quantity of graphite (for which, as far as can be ascertained, there is no known substitute) is in the manufacture of electrodes.

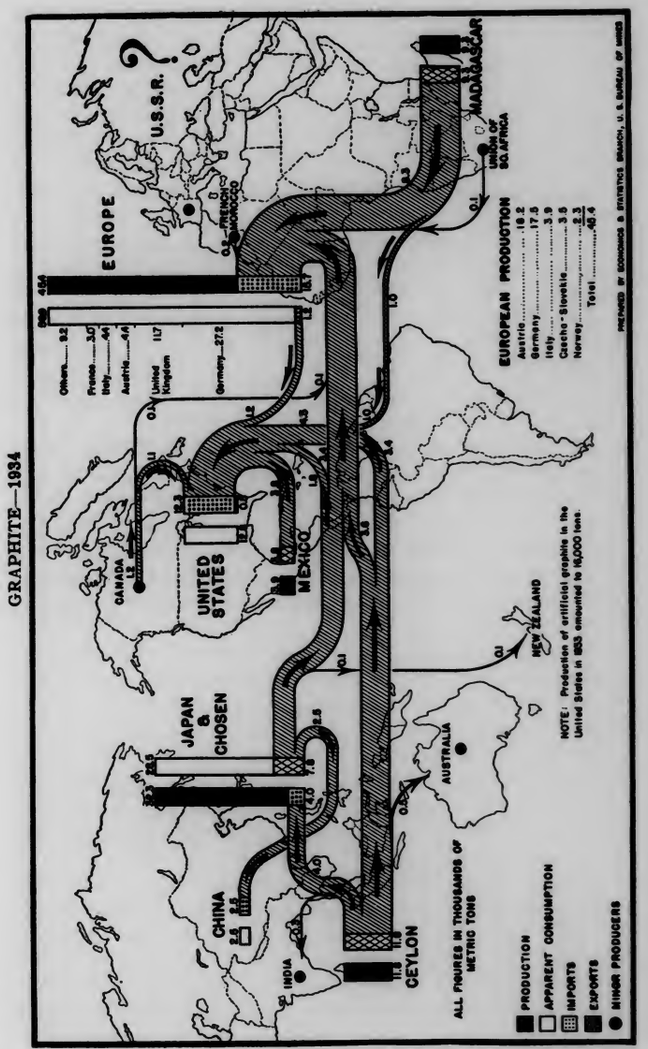
Reference

SAUFFRIGNON, R.: Le graphite; Étude technique, Paris, 1933, 50 pp.

WORLD PRODUCTION OF GRAPHITE, 1932–1934
(In Metric Tons)

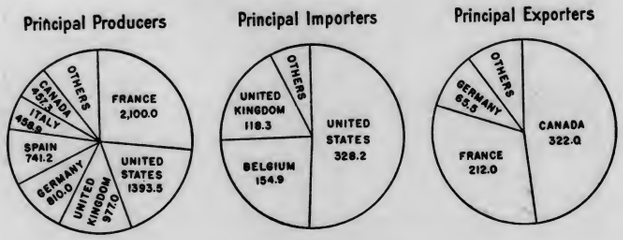
Country[1]	1932	1933	1934
Australia:			
New South Wales	.....	30	.....
South Australia	71	.....	6
Austria	10,598	14,771	18,145
Brazil[2]	.....	1	.....
Canada	314	367	1,377
Ceylon[2]	6,198	9,711	11,755
Chosen	16,733	22,677	31,294
Czechoslovakia	922	122	3,503
Germany (Bavaria)	20,808	19,755	17,535
India, British	5	.....	342
Italy	2,945	3,200	3,908
Japan	495	869	969
Madagascar	2,100	3,600	9,400
Mexico (amorphous)	2,045	2,685	3,898
Morocco, French[2]	100	66	183
Norway	672	1,983	2,281
Union of South Africa	49	59	64
United States: Amorphous	[3]	[3]	[3]
Crystalline	[3]	[3]	[3]

[1] In addition to countries listed, U.S.S.R. (Russia) also produces graphite, but data of production are not available.
[2] Exports.
[3] Bureau of Mines not at liberty to publish figures



GYPSUM — 1934

(all figures in thousands of metric tons.)



Gypsum is hydrated calcium sulphate ($CaSO_4.2H_2O$), a common, soft, white mineral. The commercial value of gypsum rests in its ability to set, after calcination, as a permanent plaster (plaster of paris) or cement. Five varieties are recognized: (1) selenite, a transparent cleavable variety; (2) satin spar, a fibrous form; (3) alabaster, a massive, translucent white variety; (4) rock gypsum, a compact granular form; and (5) gypsite, a very soft, earthy, impure form.

Most commercial gypsum deposits lie interbedded with limestones, shales, and other minerals. Gypsite occurs as a surface deposit formed by the evaporation of gypsiferous water. Dunes of gypsum sand, eroded and transported by the wind, are noted in New Mexico. Some bedded deposits may have been formed by the alteration of limestone by sulphuric acid. Satin spar and selenite occur in veins derived from solutions that have passed through gypsum beds. Gypsum is widely distributed and has been used since antiquity.

Gypsum deposits ordinarily are quarried, though underground mining is employed where the gypsum deposits lie at great depths or where the bed is tilted at a high angle. Mining practice is similar to that for mining coal.

The beds range from a few feet to 15 or 20 ft. in thickness. Care must be exercised to maintain the grade of material required

in the construction industries. Low-grade gypsum rock is used as a fertilizer. Gypsum beds may abruptly change to anhydrite ($CaSO_4$), which cannot be used in the manufacture of plasters.

Calcined gypsum and gypsum products are of higher value than the crude material and consequently can be transported greater distances. The cost of transportation is the chief obstacle to the gypsum industry. In long hauls there is the ever-present danger of dampness. In the tropics gypsum is not suitable for use as a building material because of the heavy rains and consequent dampness.

PRINCIPAL DEPOSITS

France.—The principal gypsum deposits of France, the world's largest producer, are in the Paris basin along the Marne and Seine Rivers. The deposits range from 4 to 30 m. in thickness. Other deposits are mined in Savoie, Haute-Saône, Jura, Saône-et-Loire, Côte-d'Or, Alsace and Lorraine, Nièvre, and Allier. In western France the Industry is centered about Charente. French production is about twice domestic consumption. Crude gypsum is exported to neighboring countries, and special plasters are exported overseas.

United States.—Gypsum deposits have been found in 24 states, and production is reported from 18. Reserves large enough to supply the world for centuries exist in some states, but production is limited by the demand.

Central New York is the largest producing region in the United States. In addition, large amounts of high-grade gypsum rock are imported from Nova Scotia and calcined in the vicinity of New York City. Iowa, second in production, has large deposits near Fort Dodge, Webster County. Large deposits are exploited in the vicinity of Grand Rapids, Mich. Gypsum is produced at Sandusky Bay, Ohio, and numerous thick beds occur in Texas.

United Kingdom.—About one-third of the output of gypsum in the United Kingdom comes from the Durham district of England followed by the Nottingham, Stafford, and smaller producing districts of Westmoreland and Cumberland.

Spain.—The gypsum deposits of Spain are quite widely distributed. Gypsum is produced in a number of provinces, Valencia, Madrid, and Sevilla being the most important, in the order named.

Germany.—Data concerning the German deposits are rather meager, but gypsum is known to be produced in Bavaria, Prussia, Württemberg, Brunswick, and Hesse.

Italy.—The world supply of alabaster is virtually confined to the Province of Pisa in the Leghorn district of Italy. The alabaster occurs as nodules, weighing up to 1,000 kg., embedded in the gypsum strata. There are, moreover, gypsum deposits in widely distributed areas in the districts of Caltanissetta (Sicily), Bologna, Naples, Torino, Milan, and Rome, production ranking in the order named.

Canada.—Numerous large deposits have been found in Canada, but those most extensively exploited are in the Maritime Provinces of Nova Scotia and New Brunswick, from which high-grade material may be shipped by water to foreign markets, especially the large seaboard cities of the northeastern United States. Several gypsum deposits have been developed in Ontario, Manitoba, and British Columbia.[1]

Egypt.—Egypt was the source of the alabaster of antiquity. Deposits of gypsum are found in various localities.

Algeria.—France controls the gypsum deposits of the provinces of Constantine and Oran, Algeria, where large quantities of gypsum are quarried.

Australia.—Gypsum occurs at many localities throughout South Australia. The largest deposits are along the seaboard of the Great Australian Bight. Gypsite or "seed gypsum" forms a surface deposit of some 27 sq. mi. extent at Lake McDonnell, County Kintore. The average depth of the first-quality gypsum is 2 ft. Production is reported from Victoria, New South Wales, and Western Australia.

Rumania.—The principal sources of gypsum in Rumania are in Transylvania.

Other Countries.—Gypsum is also produced in Latvia, Austria, Chile, Cyprus, Luxemburg, Union of South Africa, Tunisia, and French Morocco.

INDUSTRIAL USES

During the past 40 years the development in the use of gypsum has been remarkable. Prior to the beginning of this century practically all of the gypsum used throughout the world was consumed by farmers as fertilizer. The demand for this purpose has decreased materially, and now most of the output is consumed in the manufacture of portland cement and in the building-trade industries. Recent years have witnessed the development of a widely diversified line of products. Gypsum is used in insulation against heat and cold, a feature of modern homes. Acoustical gypsum plasters are now featured in the construction of auditoriums and offices to reduce excessive noises.

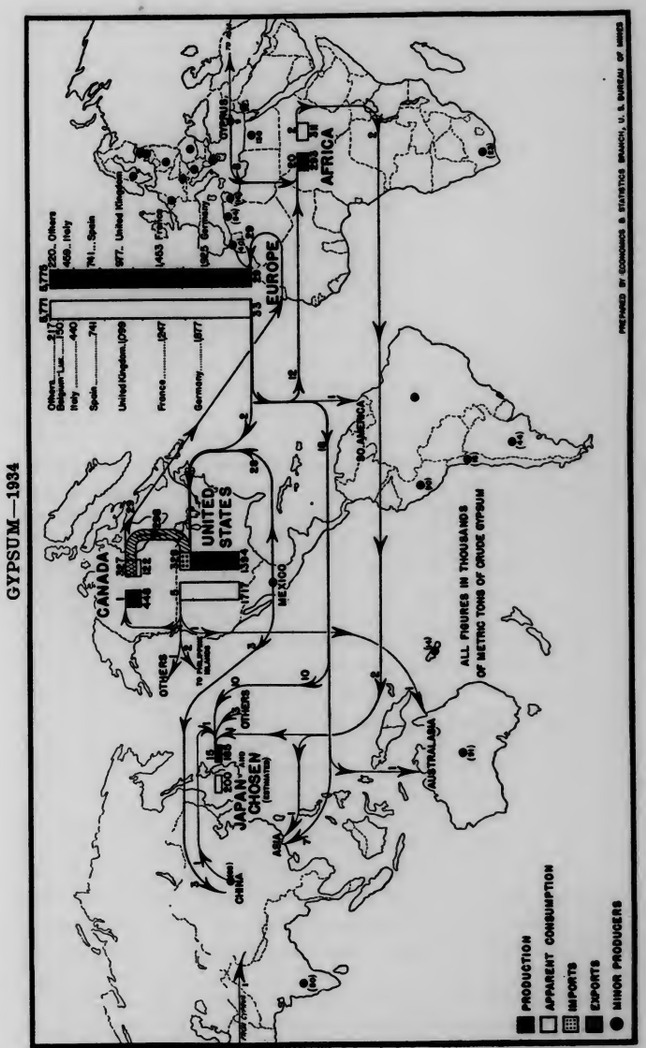
[1] COLE, L. H., The gypsum industry of Canada, *Can. Dept. Mines, Mines Branch, Pub.* 714, 1930, 164 pp.

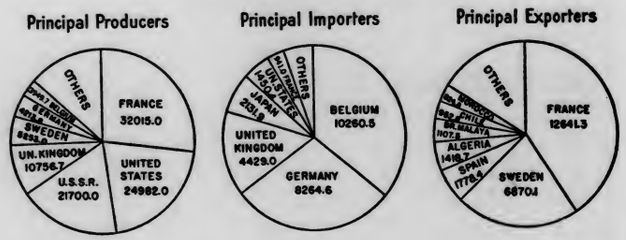
During the past 10 years world consumption of gypsum has been divided about equally between uncalcined crude and the calcined product. The calcined form is used for the manufacture of stucco, wall plaster, plasterboards, tile, and blocks and as plaster of paris for molding castings. The largest tonnage of uncalcined gypsum is employed in the manufacture of portland cement. Portland cement manufactured without gypsum sets in a few minutes, but by the addition of approximately 3 per cent gypsum or dolomite, $CaMg(CO_3)_2$, the setting is retarded. There is no known substitute for this use, and at present gypsum is considered to be essential to the cement industry. Crude gypsum is also used for agricultural purposes, as a filler, and as insulating material and in paint manufacture and rock-dusting mines. The building industries utilize the largest tonnage of calcined gypsum in such materials as base-coat, sanded, finished, and molding plasters, plasterboard and lathe, wallboard, partition tiles, and insulating materials. For manufacturing uses, plaster of paris, a form of calcined gypsum, is used as a mold in plate-glass works and terra-cotta works and in the manufacture of pottery.

World Production of Gypsum, 1932–1934
(In Metric Tons)

Country[1]	1932	1933	1934
Algeria	90,550	86,220	83,920
Argentina[2]	33,543	34,805	44,142
Australia:			
New South Wales	2,481	2,307	2,753
South Australia	45,684	51,373	76,449
Victoria	2,951	5,214	6,499
Western Australia	3,706	2,653	5,392
Austria[3]	36,000	45,000	45,000
Canada	398,883	336,283	457,311
Chile	11,989	13,682	16,200
China	53,000	65,000	[4]
Cyprus[5]	10,995	12,881	9,217
Egypt[6]	130,000	130,000	130,000
Estonia	8,299	5,670	4,905
France	2,081,010	[4]	[4]
Germany[7]	398,500	485,000	810,000
Greece	2,167	3,535	4,525
India, British	52,246	33,674	49,540
Italy	529,821	534,026	458,978
Latvia[8]	36,812	48,251	82,800
Luxemburg	9,403	12,864	10,689
Morocco, French	39,080	[4]	[4]
New Caledonia	11,900	11,565	13,585
Palestine	1,481	2,602	3,431
Peru	6,553	7,000	10,105
Poland	[4]	[4]	[4]
Rumania	40,018	57,094	47,176
Spain	697,230	709,246	741,245
Sweden	115	49	121
Tunisia	26,000	17,580	15,550
Union of South Africa	7,113	11,809	23,296
United Kingdom:			
Great Britain	1,011,399	1,000,865	977,014
Northern Ireland	41	.....	.....
United States	1,284,815	1,211,259	1,393,583
Yugoslavia[9]	[4]	842	[4]
Total	7,100,000	7,100,000	7,800,000

[1] In addition to the countries listed, gypsum is produced in Cuba, Japan, Switzerland, and the U.S.S.R. (Russia), but production data are not available.
[2] Rail and river shipments.
[3] Estimate furnished by Bundesministerium für Handel und Verkehr.
[4] Data not available; estimate included in world total.
[5] Exports of crude and calcined gypsum.
[6] Approximate production.
[7] Figures supplied by Deutscher Gips-Verein, E.V., Berlin, Germany. Figures are exclusive of rock gypsum mined and used by cement, paint, and other factories from their own quarries.
[8] Exports.
[9] Serbia only.





Although iron is one of the most abundant elements in the earth's crust, few minerals contain iron in sufficient amounts or of the right quality to be ranked as iron ores. The iron-ore minerals, in order of their importance, are: hematite (Fe_2O_3), magnetite (Fe_3O_4), limonite ($2Fe_2O_3.3H_2O$), siderite ($FeCO_3$), and the less valuable pyrite (FeS_2).

Several important impurities affect the suitability of the ore for reduction purposes, including silica, which displaces iron and at the same time requires more flux for smelting; titanium, which makes the ore refractory, drives the iron into the slag, and adversely affects the quality of the iron itself; and phosphorus and sulphur, which render the iron unduly brittle. The ideal ore is one in which the iron content is as high as possible, that is, 48 to 68 per cent, and impurities are at a minimum.

Iron deposits may be classified as follows according to origin: (1) segregation deposits crystallized from once-molten rock, such as those of Lake Sanford, N. Y.; (2) contact-metamorphic deposits, such as those of Iron Springs, Utah; (3) sedimentary ores, typified by hematite, limonite, bog ores of the Lake Superior deposits, and the Jurassic oolitic ores of England and Lorraine; (4) replacement deposits, formed by the transfer of iron by meteoric waters and the replacement of calcareous rocks, as at Bilbao, Spain; (5) residual deposits of limonite, such as the Cambro-

Silurian deposits of Virginia; (6) lenticular bodies of magnetite or pyrite in metamorphic rocks formed by the alteration of previously existing ore deposits; (7) gossan ores, limonite capping on oxidized sulphide bodies; and (8) placer deposits of magnetite sands. In general, iron deposits are lenticular or basinlike, though irregular masses are not uncommon. The ores occur in rocks of a wide geological age ranging from pre-Cambrian to Recent.

PRINCIPAL DEPOSITS

France.—France is the largest producer of iron ore, the output coming from three separate areas: (1) the minette ores of Lorraine. These bedded oolitic ores were in part reacquired from Germany at the close of the World War. The ore-bearing area is divided into a number of basins of which the Briey is by far the most important. The ores run 30 to 42 per cent iron and 1.8 per cent phosphorus. These are the largest iron-ore deposits of France. (2) Small deposits of bedded hematite and siderite in the folded Ordovician sediments of Normandy and Brittany. The ores run approximately 45 per cent iron. (3) Lenticular limestone replacement bodies of manganiferous hematite and siderite in the folded Silurian strata of the eastern Pyrenees region. The iron content runs 51 to 57 per cent.

United States.—The United States has the largest reserves of iron ore in the world. The Lake Superior district produces by far the most ore. Minnesota alone contributes two-thirds of the United States iron ore. Michigan ranks next in production, followed by Wisconsin. Iron ore is also produced in Alabama, California, Idaho, New Jersey, New York, Pennsylvania, Utah, Washington, and Wyoming.

The iron deposits of the Lake Superior region are known as ranges. Three of these ranges (the Mesabi, Vermilion, and Cuyuna) are in Minnesota, two (the Penokee-Gogebic and the Menominee) are shared by both Wisconsin and Minnesota, and the Marquette range is wholly in Michigan. The Michipicoten range in Ontario on the eastern shore of Lake Superior is similar in occurrence to the great pre-Cambrian iron ranges of the United States.

The iron ranges occur as large basins in pre-Cambrian sediments. Only the richest portion of the basin is mined by open-

pit operations, which are conducted on a large scale. The ores formerly ran over 60 per cent iron, but such ores are now exhausted and the present average is about 48 per cent iron. Where the deposits occupy narrow zones and extend very deeply underground they are worked by shafts.

In the Birmingham (Ala.) district the oolitic ores are of Silurian age. These deposits are exploited by underground workings. The ores are harder and require drilling and blasting, making extraction more expensive.

Small deposits associated with igneous rocks are mined in Pennsylvania, New York, and New Jersey.

Most of the deposits of the Western States are of small extent and of contract-metamorphic origin.

U.S.S.R. (Russia).—The Krivoi-Rog deposits of the Ukraine are the largest in the Union of Soviet Socialist Republics; there are other deposits in the central and southern Urals, where the new great Magnitnaya deposit is being developed. Some iron ore is mined in the Tula and Lipetsk districts of the Moscow region and in the Kertch region of the Crimea. Large deposits are known to lie beneath the Kursk magnetic anomaly of central Russia, but they are too deeply buried to be commercially workable at present. Recently the new Telbes-Termirtau deposits in Siberia in the Shoriya highlands south of the Kuznetsk coal basin, as well as other deposits in the Kuznetsk coal basin itself, have been developed. At present, about three-fourths of the iron-ore production comes from the Ukraine and about one-fifth from the Ural region.

United Kingdom.—The largest deposits of the United Kingdom are of Jurassic age and occur as sedimentary, oolitic iron ores. The Cleveland district is the most important, followed by the Northampton and Rutland districts, and, finally, the Lincolnshire district. The ore is an altered, impure carbonate, which is considered to be both a replacement of limestone and an original sediment. Such ores are high in phosphorus and for a long time have not been as well favored as the acid hematite ores of northern Spain or northern Sweden. The blackbands and clay ironstones of the Carboniferous system, once important iron ores, are no longer mined to any extent, owing to the high cost of mining.

Sweden.—About three-fourths of the Swedish iron-ore production comes from the magnetite mines of Gellivaara and Kiruna

in Lapland. These deposits are tabular and of huge size. The origin of the ores is difficult to explain; some occur in limestone or dolomites as replacement deposits, others in hollows or depressions of the formations above an impermeable horizon, and still a third type as a crust on an igneous rock base.[1] The mines are operated and owned by the Government.

About one-fourth of the Swedish iron production comes from several districts lying west of Stockholm in central Sweden. It was from these districts that the reputation of the Swedish iron industry arose.

Sweden has an iron industry of its own, but most of the ores are exported, particularly to Germany and the United Kingdom.

Luxemburg.—The Jurassic minette iron deposits of France extend into southwestern Luxemburg, where they underlie some 3,600 hectares in three basins. French Lorraine ores are used to supplement the Luxemburg ores. The iron content averages about 31 per cent. The future of the field is relatively limited, owing to probable exhaustion of the deposits.

Germany.—As a result of the World War Germany lost its largest iron deposits, the minette ores of Lorraine. Luxemburg, with its iron ores, has been a part of the Belgian Customs Union since 1922 and is no longer connected with Germany. At present about one-third of the domestic iron ores come from the Siegerland, in Prussia, one-fourth from the Lahn, Dill, and upper Hesse districts, and perhaps another fourth from the Peine-Salzgitter district. The Siegerland ore is manganiferous but unfortunately contains a rather high percentage of sulphur and in addition is difficult to mine. Production from this district has recently increased, although the life of the district seems quite limited. Output from the Lahn-Dill region has likewise increased, and extensive exploratory work is in progress. The old Prussian districts of Hunsrück, Eifel, and Saurerland are being explored and reopened for production. These ceased production years ago because of high costs, leaner ores, and so on. Germany has a considerable reserve, even if low grade, in the Jurassic oolitic ores of Bavaria, Baden, and Wurttemburg.[2] Intensive studies

[1] HÜLSEN, F. C. von, Mittelschwedischer Eisenerzbergbau, *Metall und Erz*, vol. 31, No. 15, Aug. 1, 1934, pp. 329–336.

[2] KOHL, E., Die Eisenerzvorräte des Deutschen Reiches, *Preuss. Geol. Land., Archiv. f. Lagerstättenfor*, 58, 1934, 184 pp.

on the utilization and beneficiation of German iron ores are under way.[3]

The proportion of native ores in the total tonnage smelted in Germany is less than 25 per cent; about one-half of the required ore is imported, and the remainder of the iron for pig iron made up from scrap materials. The Government is encouraging the consumption of German ores in every possible way. Another source of iron ore in Germany is the sulphide deposit of Meggen, of which the zinc is really a by-product. The severe drop in zinc prices resulted in cessation of operations.

Spain.—The Bilbao district is the principal source of hematite ore in Spain. The acid hematite ores are popular, especially in Great Britain, because they are low in sulphur and phosphorus. The output has declined since 1899, when a production of 6 million tons was attained. About one-third of the ore is spathic and has to be calcined. The workings are deeper now, and consequently the costs are rising. The deposits represent a replacement of limestone by descending iron-bearing solutions.

India.—The commercial iron deposits of India are in Bihar and Orissa. These hematite ores occur in Pre-Cambrian rocks similar to those of the Lake Superior district of the United States.[4] The ores are smelted chiefly at the Jamshedpur plant of the Tata Iron Co. The Bengal Iron Co., is situated in Kulti in the Raniganj coal field and uses ores in Singhbhum. The Indian Iron & Steel Co., at Asansol near Kulti, is in the Asansol coal field. The small Rhadravati Iron Works is in Mysore. Other iron deposits of magnetite, laterite, clay iron-stones, and hematite ores occur in Burma, Central Provinces, and the United Provinces. Some of these ores have been worked from time to time, but the chief drawback to their continuous utilization is the lack of sufficient and appropriate fuel (coking coal).

China.—The iron ores of China are, in general, in the river plains region relatively near the sea. The coal deposits are farther inland. Both the iron and coal resources are known only in a general way, however. The largest reserves are in the Province of Fengtien, followed by Hopeh, Hupeh, and Kiangsu. China has the largest iron reserves in the western Pacific region.[5] The most important iron-ore deposits now being mined are in Manchuria, at Penchihu and Anshan. The Manchurian product is exported to Japan as pig iron. The ores run 50 to 68 per cent iron. Other deposits exploited are in Hopeh (Hsuan Lung deposits) and in the Province of Hupeh. Ores from the Santung and Yangtze regions are shipped to Japan, which absorbs the greater part of the Chinese iron-ore production.

[3] LUYKEN, W., Ueber die Entwicklung des deutschen Eisenerzbergbaues: *Metall und Erz.* vol. 33, No. 1, Jan. 1, 1936, pp. 2–11.

[4] JONES, H. C., The iron ore deposits of Bihar and Orissa, *Geol. Survey India Mem.*, vol. 63, pt. 2, 1934, pp. 167–301.

Unfederated Malay States.—Magnetite deposits are mined in the State of Trengganu of the Unfederated Malay States and are then exported to Japan.

Australia.—The iron reserves of South Australia are the largest and richest in Australia.[6] These ores were once mined at a considerable number of localities. Massive pre-Cambrian hematite deposits outcrop as hills above the surrounding country. Mining is carried on in open cuts, and the waste is very small. Enormous tonnages of ore are available above ground, and probably a very large amount exists below the ground. Mining can be said to have hardly more than begun.

Recent advices report the beginning of the exploitation of the iron deposits on Iron Island of the Northumberland group midway between Rockhampton and Mackay, Queensland. The ores are to be shipped to Japan. They run about 65 per cent iron and are in part hematite and in part magnetite.

Another iron-bearing region is the large hematite area on Cockatoo and Koolan Islands of the Buccaneer archipelago on the northwest coast of Australia. These deposits are difficult to develop because of the severe climate, the absence of labor, fresh water, and the tidal rise of 27 ft. which would make shipping difficult.

The principal iron works are the Australian Iron & Steel, Ltd., in Sydney and the Broken Hill Proprietary Co., Ltd., in Melbourne and Newcastle.

Algeria.—About 1865, production was begun from the Algerian iron deposits near the coast; later, with the coming of the rail-

[5] BAIN, H. F., Ores and industry in the Far East, New York, 1933, 288 pp.

[6] LEWIS, E., Iron ore deposits of Australia, *Chem. Eng. Mining Rev., Melbourne*, vol. 21, No. 247, Apr. 5, 1929, pp. 257–260.

ways and the search for richer deposits, mining of the inland deposits was initiated.[7] Today the country has been quite well prospected, and the probability of finding new iron deposits rests on the use of geophysical prospecting. Algeria has four producing deposits, all hematite that has replaced Mesozoic limestones. About one-third of the ore comes from the Ouenza district, well inland and near the Tunisian border.

Chile.—In the Atacama Desert of northern Chile are large iron deposits, including the Algarrobo and the Tofo. The Tofo has been developed because the Panama Canal enables the ores to be brought cheaply to North America. A deposit developed for export purposes must be one in which the costs are low, the location near the sea, with abundant cheap labor at hand, and the potential output at least 1 million tons of high-grade ore annually. The Chilean deposits fill these qualifications very well. The tenor of the ores runs 66 per cent iron from Tofo and 64 per cent iron from Algarrobo. The Tofo deposits are controlled by capital from the United States, while the Algarrobo deposits are controlled by Dutch and German capital. The remaining Chilean deposits are smaller but of equally high quality. Plans to establish a local smelting industry, have long been considered using Chilean coal for coking purposes.[8]

Spanish Morocco.—The iron deposits of Spanish Morocco, located as they are quite near the coast and the Port of Melilla, have a favorable position at the entrance to the Mediterranean Sea. Production in Spanish Morocco was begun in 1914 at the outset of the World War. The Spanish Rif ores are composed of hematite and magnetite and are of contact-metamorphic origin.

Tunisia.—Across the Algerian boundary is the Djerissa iron district, which produces over two-thirds of the Tunisian iron ore. It runs 50 to 54 per cent iron. Near the north coast of Algeria in the vicinity of Oran, and between Oran and Alger, and on the north Tunisian coast, are smaller hematite deposits.

Brazil.—Brazil has very large sedimentary pre-Cambrian iron-ore deposits occupying 100 sq. mi. in Minas Geraes. Production from these deposits is very small at present.

[7] BETIER, G., Les gisements de fer nort-Africains, in Les ressources minérales de la France d'outre-mer, Paris, vol. 2, 1934, 75 pp.

[8] FRITZSCHE, C. H., Der Eisenerzbergbau in Chile und Aussichten einer heimischen Eisenhüttenindustrie: *Stahl und Eisen*, vol. 51, No. 18, Apr. 30, 1931, pp. 541–547.

French Morocco.—Three iron deposits at widely separated localities are known in French Morocco. No production is yet recorded, but it is planned to connect certain of these deposits with the coast by rail.

INDUSTRIAL USES

The availability of cheap power and the means of converting this power to useful purposes are vital to the industrial development of any political subdivision of the world. The commercial development of the United States, Great Britain, France, Russia, Japan, and Germany depends upon sources of iron ores as well as coal. To these six countries may possibly be added, at some time in the future, Canada and China.

By far the greatest part of the iron ores produced in the world is used in the manufacture of pig iron, from which steel is derived. In the manufacture of steel not only pig iron is employed but iron ores are added for fluxing purposes. For such uses as pigments, cement, gas purification, hydrogen gas, in the smelting of silver-gold ores as well as the nonferrous ores and in the manufacture of ferroalloys, a relatively large tonnage of iron ore is consumed, but the total amount is but a fraction of the tonnage required in the manufacture of pig iron and steel.

SUBSTITUTES

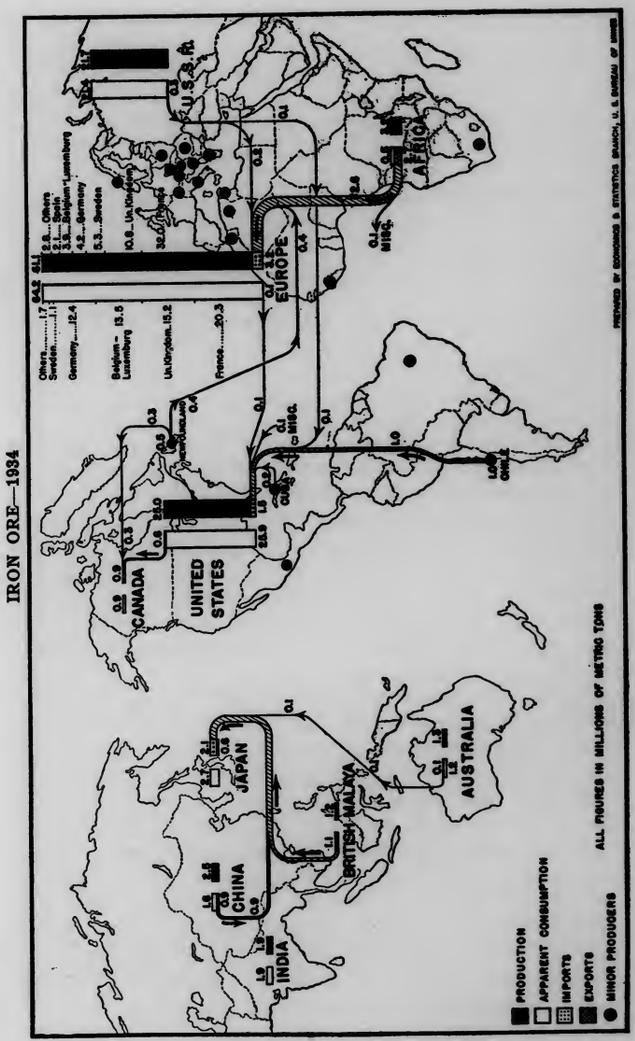
At present, no satisfactory substitutes for iron ores in industry are known.

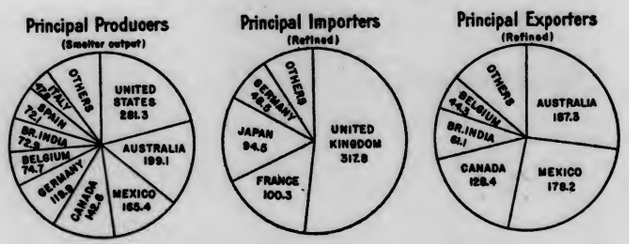
WORLD PRODUCTION OF IRON ORE, 1932–1934
(In Metric Tons)

Country	1932	1933	1934
Algeria	466,930	761,454	1,326,437
Australia:			
New South Wales	.....	2,471	.....
Queensland	8,364	8,690	3,282
South Australia	546,562	732,760	1,264,205
Austria	306,796	267,032	466,835
Belgian Congo	14,614	[1]	[1]
Belgium	92,810	106,200	115,890
Brasil[2]	30,000	30,000	30,000
Chile[3]	172,681	559,598	969,285
China[4]	2,294,219	2,456,870	[1]
Chosen	390,937	258,267	176,008
Cuba[5]	82,610	169,490	181,121
Czechoslovakia	602,215	428,772	538,742
Egypt	25	.....	203
France	27,599,320	30,245,000	32,015,000
Germany[6]	1,319,142	2,534,768	4,213,869
Greece	46,022	85,221	147,408
Hungary	52,864	50,021	68,862
India, British	1,788,757	1,248,344	1,947,685
Indo-China	.....	420	1,500
Italy	412,326	507,995	484,583
Japan	226,722	320,670	[1]
Luxemburg	3,212,618	3,362,417	3,833,847
Mexico	27,122	77,714	105,799
Morocco: Spanish zone[7]	171,182	515,838	824,812
Newfoundland[8]	150,867	240,934	661,477
New Zealand	.....	6,588	2,851
Norway	373,907	473,863	567,414
Poland	78,869	160,661	247,365
Portugal	.....	4,500	2,895
Rhodesia: Northern Rhodesia	722		
Rumania	8,051	13,831	83,590
Sierra Leone	.....	24,944	233,148
Spain	1,760,471	1,815,484	2,094,001
Sweden	3,298,989	2,698,750	5,253,058
Switzerland[7]	11,862	7,089	18,961
Tunisia	209,000	291,000	546,500
Unfederated Malay States	699,224	778,774	1,153,876
Union of South Africa[5]	31,696	60,060	228,913
U.S.S.R. (Russia)	12,200,000	14,500,000	21,700,000
United Kingdom[9]	7,445,807	7,581,481	10,756,765
United States	10,004,959	17,834,917	24,982,047
Yugoslavia	26,635	52,465	179,841
Total	76,200,000	91,300,000	120,400,000

[1] Data not available.
[2] Approximate production.
[3] Production of Tofo Mines.
[4] Including Manchuria.
[5] Shipments.
[6] Exclusive of manganese ore carrying 12 to 30 per cent manganese.
[7] Exports.
[8] Shipments from Wabana Mines.
[9] Exclusive of bog ore which is used mainly for purification of gas.

IRON ORE—1934





In nature, lead[1] is closely associated with zinc and often with silver; in fact, lead ore as such is mined only in Spain. Lead ores are, however, widely distributed. The chief ore minerals are: galena, the sulphide; cerussite, the carbonate; and anglesite, the sulphate. Lead compounds are insoluble, and very little secondary enrichment or migration of lead occurs. The gangue minerals are calcite, dolomite, siderite, barite, fluorite, quartz, chert, pyrite, and marcasite. The lead ores may also contain zinc, silver, gold, antimony, arsenic, and copper. The tenor of the ores varies widely.

The lead ore bodies assume many different forms but those occurring as replacements in limestone are the most common. These limestone replacement deposits are of two types: (1) lead deposits which, though associated with zinc, have little or no silver, gold, antimony, or arsenic (deposits of the Tri-State district of the United States are of this type) and (2) silver-lead replacement deposits in which the mineralogy is quite complex, as the ores also contain zinc, arsenic, antimony, copper, and minor metallic constituents. Park City and the Tintic districts of Utah illustrate this type of deposit. Lead-bearing minerals associated with copper in Permian and Triassic sandstone occur and are termed *red beds*. Examples of these "red-bed" deposits

[1] Imperial Institute, Lead (2nd ed.), London, 1933, 253 pp.

are known at many localities in the western United States. Other occurrences of lead are of the vein type, with many possible variations in their classification due to a more or less complex mineralogy.

Lead ores usually contain a considerable quantity of gangue and other mineral matter which must be removed before smelting. Concentration processes involve the use of jigs and shaking tables or the newer and more efficient flotation methods.

The metallurgical treatment depends on the mineralogical complexity of the lead ores. In general, the ores are roasted, sintered, and smelted in blast furnaces; the metal is then desilverized by the Parkes, Pattinson, or Betts (electrolytic) process. Lead smelting is fairly simple and requires neither highly skilled labor nor large amounts of fuel as contrasted with zinc. The smelting of lead is therefore generally done at the centers of production. The refining process enables such valuable metals as gold, silver, copper, zinc, antimony, arsenic, and bismuth to be recovered as by-products.

PRINCIPAL DEPOSITS

United States.—The United States is the largest producer of lead in the world, supplying about one-fifth of the total production. Nearly all (95 per cent) of the lead is produced from domestic ores. Southeastern Missouri is the largest single producing district. However, the Western States area is the chief producing section, and Idaho and Utah contribute the largest output. Other states in this province producing lead ores are Arizona, California, Colorado, Montana, Nevada, New Mexico, and Washington. The Central States region, consisting of Arkansas, Illinois, Kansas, Kentucky, Missouri, Oklahoma, and Wisconsin is the second largest producing section. A small amount of lead ore is mined in the eastern section, comprising New York, Tennessee, and Virginia. The decline in production of lead in certain base-metal districts has been offset by the increased production of lead associated with silver ores in other districts.

The recovery of secondary lead increased steadily until the general business recession, and even since then it has declined less than primary lead production.

Australia.—Australia is the second largest producer of lead. Broken Hill, New South Wales, is the principal source of the ores, which are associated with zinc and silver in a great lode situated in a fault zone.[2] The Mount Isa district, Queensland, is a new low-grade producer of world importance. Low prices have adversely affected the development of this deposit. The Lake George mine, New South Wales, is a large new operation not yet brought into production. Before the World War a large part of the Australian ore was shipped to Germany for smelting. Smelters were erected at Fort Pirie, South Australia, and Cockle Creek, New South Wales, which has rendered export of concentrates unnecessary.

Mexico.—The chief lead-producing regions of Mexico are the Santa Bárbara and Santa Eulalia deposits of the State of Mapimi; the Cautro Ciénegas and Sierra Mojada districts of Coahuila; and the Charca district of San Luis Potosi. The ores are complex sulphides occurring as chimneylike bodies or irregular replacement deposits in limestones. Very rich mines have been worked in Mexico.[3]

Canada.—Nearly all of the lead production of Canada comes from the Sullivan mine in British Columbia. The ores occur as enormous sulphide lenses replacing argillites. The smelter at Trail, British Columbia, is the only lead smelter in Canada.[4]

British India.—The Bawdwin mines of Burma, controlled by British interests through the Burma Corporation, are the largest producers of lead in British India. The deposits are at Tawnpang 600 miles north of Rangoon. Large bodies of sulphide ore occur as replacement deposits along a fault zone.

Spain.—Lead is mined in the southern part of Spain in the Linares and Cartagenian districts. Spanish production of metallic lead attained a peak in 1913, with 202,997 metric tons of metallic lead. The annual output declined steadily since

[2] *Australasian Inst. Mining Met., Proc., n.s.* 87, Sept. 20, 1932.

[3] HAYWARD, M. W., and W. H. TRIPLETT, Occurrence of lead-zinc ores in dolomitic limestones in northern Mexico, *A.I.M.E., Tech. Pub.* 442, 1931, 31 pp.

[4] ALCOCK, F. J., Zinc and lead deposits of Canada, *Can. Dept. Mines, Geol. Surv., Econ. Geol. Ser.* 8, 1930, 406 pp.; Lead and zinc deposits of the Cordilleran region, *Canada: Fifth Pacific Congress, Proc.*, vol. 2, 1934, pp. 1425–1430.

that time owing to exhaustion of the deposits and the competition of newer low-cost producers. Government aid has been extended to the industry since 1927.

Yugoslavia.—The Trepca mines of southern Serbia are the principal producers of lead in Yugoslavia. Further increase in production is anticipated, as the Kopaonik mines, which adjoin the Trepca, are about to enter production. There are also important lead mines in Slovenia, the Mezica (Misitsa or Miess) mines and smelter being controlled by British capital.

Germany.—Germany is a large producer of metallic lead. Ores are imported from Yugoslavia and Newfoundland for smelting. The domestic production comes from the Bleischarley mine of Upper Silesia, the Harz region, and a number of widely scattered localities in the lower Rhine Valley, extending from Aachen southward almost to Frankfurt-am-Main.

United Kingdom.—Lead ores are produced in the United Kingdom from a number of localities in northern England. Production of pig lead is not large enough to supply the nation's needs, the deficiency being made up by imports chiefly from Australia but also from Canada and India.

Newfoundland.—The complex sulphide ore of the Buchans mine is the source of the lead concentrates that are exported from Newfoundland.

U.S.S.R. (Russia).—Lead production has increased in the Union of Soviet Socialist Republics but is still far behind the program of the Second Five-year Plan, which set a quota of 147,000 tons for 1934. Recent increases have been due to the completion of the Chimkent smelter. The Turlan deposits in the Karatau Mountains in southern Kazakstan are considered to be the largest zinc-lead deposits of the U.S.S.R. Lead is now being produced in the Sadon district of the northern Caucasus region, which also produces some silver. The ores are smelted at Alagir.[5] Some lead is obtained from the Ridder mine in the Semipalatinsk region of Siberia. Lead-bearing ores are reported in the Nerchinsk district of the Transbaikalia Province and the Kara-Mazar district of Turkistan.

Italy.—Italy produces lead from the Iglesias district of southwestern Sardinia and on the mainland from the Raibl mine of the

[5] SKAKOVSKY, N. R., The Sadon deposit of silver-lead-zinc ores, *Russia Sci. Res. Inst.* 425; *Inst. Econ. Mineralogy* 50, 1931, 224 pp.

Trieste district. During the last few years the Government has subsidized the industry.

Greece.—Large lead-zinc-silver mines that were worked by the ancients for silver are found at Laurium 25 miles southeast of Athens. They have been exploited in recent years by French companies for their zinc content, which is found in increasing amounts in the deeper levels.

Tunisia.—Smelter production in Tunisia is derived largely from imported ores shipped in from Yugoslavia.

France.—A small amount of ore is produced in France. An effort is being made to subsidize production. The deficiency of the supply from domestic sources is made up by importing ores supplemented by much larger tonnages of pig lead.

Other Countries.—Other countries producing lead ores are: Algeria, Argentina, Austria, Bolivia, Brazil, China, Czechoslovakia, Finland, French Morocco, Japan, Nigeria, Northern Rhodesia, Norway, Peru, Poland, Rumania, Spanish Morocco, Sweden, and Turkey.

The principal consuming nations are Belgium, France, Germany, Italy, Japan, U.S.S.R., United Kingdom, and the United States. The United States is well supplied with ores, but Great Britain, which can draw upon adequate reserves within the Empire, must go overseas to obtain the metal. The remainder of the great consuming countries must import large quantities of ore or metal, chiefly from sources not under their control. Italy is perhaps an exception to this and comes very near self-sufficiency.

INDUSTRIAL USES

The utilization of lead is based largely upon its durability, weight, malleability, comparatively low melting point, resistance to corrosion from many chemicals, and electrical properties, as well as its adaptability to the manufacture of pigments. Throughout the industrial world there are many industries to which this metal is indispensable.

Its usefulness may be realized when thought is given to the many lead commodities in daily use. In automobiles, not only does lead form the principal element used in the manufacture of storage batteries, but it is now employed as a chemical to produce antiknock gasoline. Another application to which lead is particularly adaptable is in the manufacture of pipes used, as a rule, as water conduits. Lead alloys readily with many metals in all proportions. It is hardened by the addition of comparatively small percentages of antimony, tin, arsenic, and calcium.

During the last 15 years the largest part of the lead required industrially has been used in the manufacture of cable coverings. Lead covered cables can be employed overhead, underground, and under water. Not only does the lead used in this manner protect the wire from damage, but it has enabled the telephone companies to place more than 1,800 wires within one cable, thus making possible great economy in space. Lead has made it possible to increase the use of the telephone materially.

Battery grids or battery plates consume the second largest amount of lead. During the last 50 years the use of storage batteries has become so common that we seldom consider how dependent we are upon lead for our modern conveniences. As there is now no known substitute for storage batteries, the use of most automobiles therefore depends upon lead. More than 75 per cent of all storage batteries manufactured are requisitioned for use in automotive types of machinery. Storage batteries have, moreover, made possible the development of submarines.

The third largest amount is consumed as a pigment—white lead. White lead is used for protecting against weathering the surface to which it is applied as well as because of its hiding and covering power.

The fourth largest amount is normally used in the manufacture of ammunition.

SUBSTITUTES

For many uses of lead there are few commercial substitutes. Zinc white, lithopone, and titanium oxide may be substituted for it in pigments.

WORLD MINE PRODUCTION OF LEAD, 1932–1934
(In Metric Tons)[1]

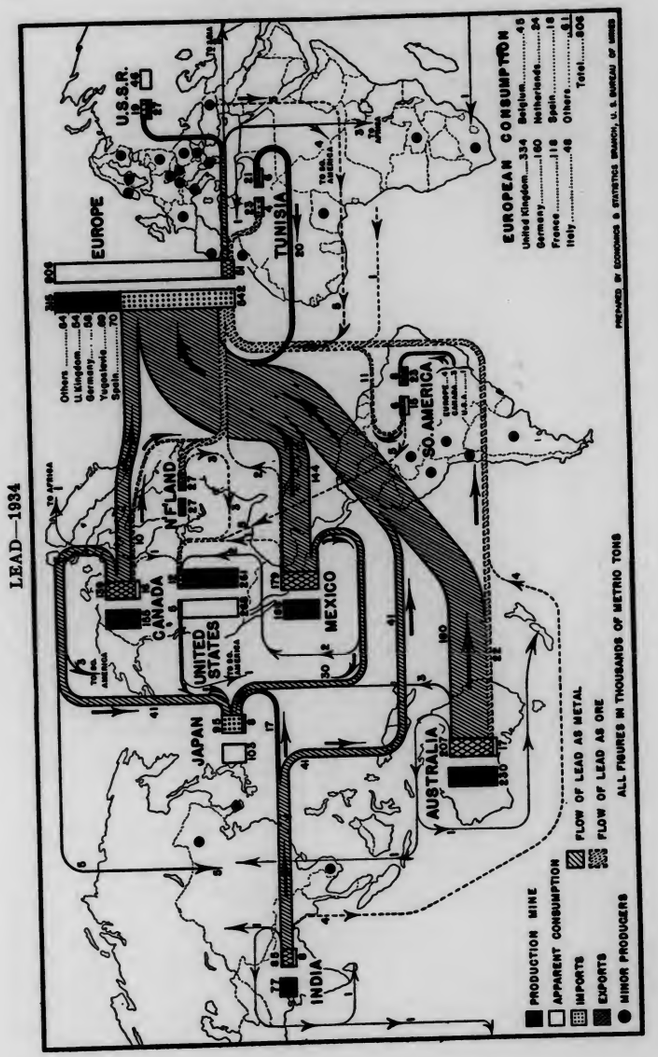
Country	1932	1933	1934
Algeria	2,300	390	640
Argentina	4,000	4,000[2]	3,000
Australia	213,946	225,450	233,514
Austria	4,811	6,309	5,266
Bolivia[3]	5,488	7,845	11,200
Brazil[3]	500	150	80
Bulgaria	6	272	.....
Canada	116,095	120,870	157,067
Chile	9,149	32	.....
China	3,186	3,207	3,000[2]
Chosen[4]	493	784	1,806
Czechoslovakia	4,600	4,200	4,500
Finland	152	339	404
France	3,220	1,250	2,000[2]
Germany	68,663	53,660	57,000
Greece	6,758	12,980	24,255
Guatemala	77	63	74
Hungary[4]	.....	11	42
India, British	80,100	97,600	90,225
Indo-China	.....	.....	7
Italy	21,615	17,908	19,437
Japan[4]	6,415	6,825	6,778
Mexico	137,600	118,693	166,333
Morocco:			
French zone	1,800	22	139
Spanish zone	928	694	68
Newfoundland	36,200	34,900	33,700
Nigeria	447	646	447
Northern Rhodesia[4]	.....	75	187
Norway	858	830	500
Peru	4,600	1,946	9,103
Poland	3,859	5,576	5,884
Portugal	103	212	3
Rumania	2,848	3,181	2,773
South-West Africa[5]	5,100	.....	.....
Spain	100,000	75,100	66,400
Sweden	7,308	7,520	8,248
Tunisia	6,400	3,800	4,200
Turkey	.....	2,800	6,200
Union of South Africa	69	88	76
U.S.S.R. (Russia)[4]	18,800	13,700	27,000
United Kingdom	33,441	40,373	54,680
United States[6]	265,775	247,367	260,753
Yugoslavia	49,462	61,111	70,170
Total	1,227,000	1,183,000	1,337,000

[1] Lead content of ores produced, except as otherwise noted.
[2] Approximate production.
[3] Exports.
[4] Smelter output.
[5] Year ended Mar. 31 of year following that stated.
[6] Recoverable content.

WORLD SMELTER PRODUCTION OF LEAD, 1932–1934
(In Metric Tons)[1]

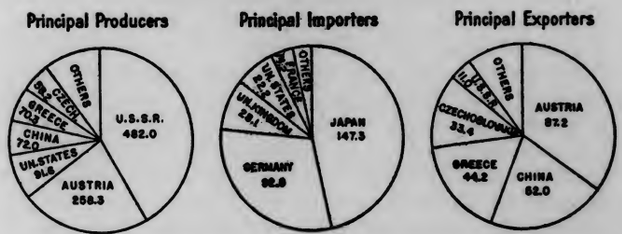
Country[2]	1932	1933	1934
Argentina	3,481	2,799	5,000
Australia	189,347	208,558	199,151
Austria	1,986	4,626	5,629
Belgium	64,160	69,390	74,750
Canada	114,820	115,469	142,635
Chosen	453	784	1,806
Czechoslovakia	4,124	3,811	4,066
France	19,600	20,400	17,867
Germany[3]	95,216	116,600	119,980
Greece	6,482	8,205	8,899
Hungary	.....	11	42
India, British	72,345	73,201	72,968
Indo-China	16	18	15
Italy	31,471	24,756	47,843
Japan	6,415	6,825	7,039
Mexico	137,099	118,460	165,416
Northern Rhodesia	.....	75	187
Norway	435	365	333
Peru	327	497	1,998
Poland	11,902	12,065	10,350
Portugal	109	70	54
Rumania	1,938	4,082	4,382
South-West Africa[4]	1,044	408	.....
Spain	105,370	88,354	72,151
Tunisia	14,082	14,873	27,311
U.S.S.R. (Russia)	18,800	13,700	27,000
United Kingdom	7,100	5,600	9,100
United States (refined)[5]	251,365	242,483	281,300
Yugoslavia	8,321	6,336	9,803
Total	1,168,000	1,163,000	1,317,000

[1] By countries where smelted but not necessarily where refined.
[2] In addition to the countries listed, China smelts lead, but no reliable data of output are available.
[3] Exclusive of secondary material (Metallgesellschaft, Frankfurt).
[4] Year ended Mar. 31 of year following that stated.
[5] Figures cover domestic refined and lead refined from foreign ore; refined lead produced from foreign-base bullion not included.



MAGNESITE — 1934

(all figures in thousands of metric tons)



Magnesite[1] is a carbonate of magnesia consisting of magnesium metal combined with carbonic acid, or of 47.6 per cent of magnesium oxide and 52.4 per cent of carbon dioxide. Pure magnesite is generally a white, very fine grained, compact, minutely crystalline rock that occurs in veins. This variety is known as amorphous or cryptocrystalline magnesite. A second type of magnesite is a massive, more or less coarsely crystalline rock in many colors—white, gray, black, pink, or even red—that occurs in beds like a sedimentary rock. In nature it includes some silica, clay, serpentine, and oxides of iron. Three types of deposits are recognized: (1) veins in serpentine exemplified by the deposits of California or Greece; (2) magnesite replacements of dolomite or limestone, such as the deposits of Washington, Austria, and Quebec; and (3) magnesite as a sedimentary rock, such as the beds of Kern County, Calif.

If magnesite is burned it loses its carbon dioxide at temperatures ranging from 510 to 700°C. This product, burned at about 1200°C., is known as caustic magnesite and contains 2 to 5 per cent carbon dioxide. Caustic magnesite takes up carbon dioxide on exposure to the air, thereby deteriorating. Dead-

[1] HIMMELBAUER, A., Magnesit, in STUTZER, O., Lagerstätten der Nicht-Erze, Berlin, vol. 5, 1933, pp. 249–319.

TYLER, P. M., Magnesite, *U. S. Bur. Mines, Inf. Cir.*, 6437, May 1931, 53 pp.

burned magnesite requires higher temperatures of burning, ranging from 1550 to 1900°C.; thereby the carbon dioxide content is reduced to less than 1 per cent, and the product remains inert in the presence of air, unlike the caustic variety. Magnesite is calcined in vertical-stack kilns fired with wood, coal, oil, or coke and in rotary cylindrical kilns fired with oil or powdered coal.

Magnesite is quarried from open pits or mined by tunnels and stopes, the method employed depending upon the size of the deposit and its relation to the surface.

The European Magnesite Cartel was founded in 1922 and is composed of the leading European producers. The central and main selling office is the "Magnesite A.G." of Basel, Switzerland. One of the major problems confronting the cartel is that of allowing Soviet Russia a quota in the European market. Under the terms of the magnesite cartel all orders, except those from the United States, Canada, and Mexico, are distributed to the various companies according to a quota percentage. Prices in different markets vary according to local conditions.

Before the World War the Austro-Hungarian Empire controlled a world monopoly on the supply of dead-burned magnesite. The war effected a change, substitutes were developed, new deposits were exploited, and the Austrian exports fell accordingly.

PRINCIPAL DEPOSITS

U.S.S.R. (Russia).—The world's largest producer of magnesite is the Union of Soviet Socialist Republics. The most important desposits are located in the Ural Mountains, at Satka in the Zlatusk district of the central Urals, and in the Orsk and Miass regions in the southern Urals. At Satka, the chief source of the Russian supply, magnesite replaces limestones, while in the Orsk and Miass regions it appears as fracture zones in serpentine. The magnesite is low in iron, and the deposits are mined by means of open cuts.

Austria.—Most of the Austrian magnesite is of a crystalline character, but small bodies of the massive or amorphous type are exploited. The latter class represents 10 to 20 per cent of the total production. The crystalline magnesite is especially valuable, owing to its high content of ferric oxide, ranging from 3 to 5 per cent. The largest deposit is that of Veitsch in Styria; other deposits are those of Oberdorf and Kraubauth and Radenthein, all in the same general zone of the central Alpine core extending from Lower Austria westward to Tirol. South of this zone in Styria and Kärnten are a number of magnesite deposits.

The export tax on raw and dead-burned magnesite is a retarding influence, and the loss of Bohemian coal has also handicapped the industry. These factors may be offset in part by the facts that the deposits are of huge size and comparatively accessible, and that there is an abundant supply of cheap labor. The crystalline state and the presence of iron permit easier calcination by lowering the melting point. Over 90 per cent of the production is exported; consequently the magnesite is more dependent on conditions in the iron and steel industries abroad than on domestic economic conditions.

United States.—The magnesite deposits of the United States are in Stevens County, Wash., and in California in the Coast Ranges southward from Mendocino County to Los Angeles. Deposits also occur on the west slope of the Sierra Nevada from Placer County to Kern County. The production centers about Porterville, in Tulare County. A sedimentary magnesite deposit is found at Bissell, Kern County. Magnesite in the Coast Ranges occurs as veins in serpentines ranging from 2 to 24 ft. in width. The Washington magnesite is low in iron, which must be added to the furnace linings. The deposits are conveniently situated near railroads and can be efficiently mined.

Greece.—The serpentine belt of Serbia continues southward into Greece or into Macedonia and the Chalcidice Peninsula. The magnesite occurs in several localities in this region.[2] The magnesite veins are found in fractured serpentines. More important than these deposits are the deposits of Euboea on the east Aegean coast of Greece, where the magnesite occurs in fault or shear zones in the serpentines. Only the best quality of magnesite is exported.

Czechoslovakia.—The magnesite deposits of Czechoslovakia are located in Slovakia and show a similarity to those of Austria.[3] They occur in a zone 120 km. long extending in the Szepes-

[2] HIESSLEITNER, G., Zur Lagerstättengeologie des dichten Magnesits in Griechenland und Serbien, Berg- und -Hüttenm., *Jahrb. Leoben*, vol. 82, No. 1, 1934, pp. 24–41.

[3] REDLICH, K. A., Die Magnesitvorkommen der Cechoslovakischen Republik, *Serv. Geol. Rep. Tchécosl., Vestnik*, vol. 10, 1934, pp. 121–134.

Gömörer Mountains from Lučenec in the west to Košice in the east, where high-grade producing deposits are found in a number of localities. Production from the serpentine deposits of Bohemia and Moravia is very small.

Manchuria.—In 1913 an immense deposit of magnesite was found in southern Manchuria in the Liaotung Peninsula, Fengtien Province. These deposits are situated near and are owned by the Southern Manchurian Railway. The deposits of crystalline magnesite occur in a pre-Cambrian dolomite, into which they grade. The deposits are said to range up to 900 m. in thickness. Various replacement and sedimentation theories have been proposed to account for their origin.

Yugoslavia.—The magnesite deposits of Yugoslavia are related to a northwest-southeast belt of basic igneous rocks which extends from Bosnia across the Balkans to Salonika, Greece. At a number of localities these altered serpentines bear veins of magnesite in commercial amounts.

India.—Magnesite is won by quarrying in the serpentines of the Salem district of the Madras Presidency, India. The output is exported as calcined magnesia; very little crude is being exported, despite the equipment of the company to produce large amounts of raw magnesite. A large amount of magnesite was mined here in war time to serve as a substitute for the Austrian product. Magnesite deposits in Mysore have been acquired by the Tata Iron & Steel Co. to make refractory bricks for the Jamshedpur plant. Production from these deposits has been erratic. In general, Indian magnesite is nearer the Greek than the Austrian type.

Canada.—The Canadian production of magnesite rose during the war. It comes from one deposit, in Argenteuil County, Quebec, where it appears in altered dikes in limestones.[4] The high lime content affects the value of the deposits.

Australia.—Magnesite occurs in red clay by a weathered serpentine near Fiffield, New South Wales, Australia. Small amounts of magnesite are also produced in Queensland, South Australia, and Victoria.

Italy.—Magnesite is produced in Italy from a number of deposits in Tuscany.

[4] COMBER, A. W., Magnesite in the British Empire, *Mining Mag.*, vol. 50, No. 1, January 1934.

Other Countries.—Norway, Turkey, and the Union of South Africa supply some magnesite.

INDUSTRIAL USES

The never-ending search for a light, durable, high-tensile-strength metal or alloy has led to a material increase in the production and use of the metal magnesium, as the lightest structural metal commercially available. The essential industrial use of magnesite is in metallurgy, as a refractory material for lining furnaces. There is no technically satisfactory substitute for magnesite brick. Chrome brick, however, are used for the same purpose because of their lower price.

In the building trades the various compounds of magnesite meet the keen competition from other minerals. In the near future it may well be that the market for magnesium metal may increase materially. This suggestion is based upon the fact that the present trends are toward reduction in weight for such commodities as cars, buses, trucks, trailers, airplanes, and portable equipment, and magnesium metal or an alloy may well meet this trend. Should this development take place, keen competition between aluminum and magnesium, as well as special high-strength alloy steels, will result. Magnesium is one-third lighter than aluminum, and although the volume of production is still small it has become one of its chief competitors.

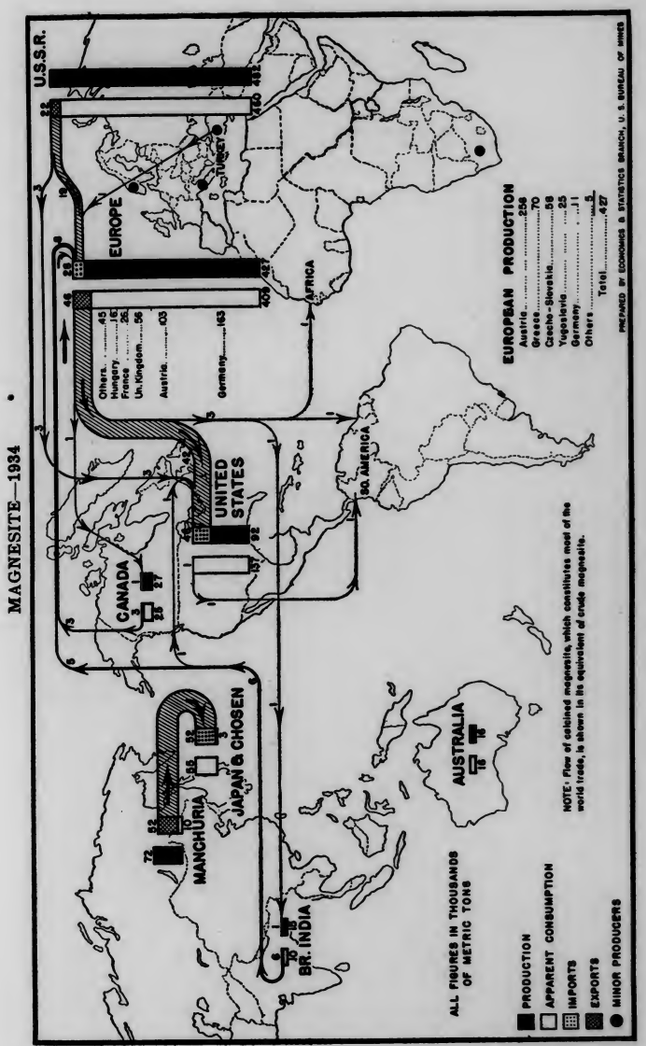
SUBSTITUTES

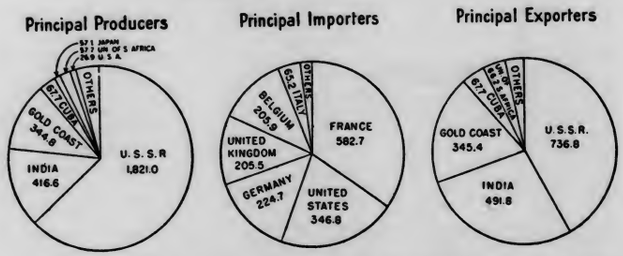
In the manufacture of stucco, plaster boards, and such building materials as base-coat, sanded, finished, and molding plasters, plasterboard and lathe, wallboard, partition tiles, and insulating materials, magnesite has many competitors among which it would be difficult to choose substitutes.

WORLD PRODUCTION OF MAGNESITE, 1932–1934
(In Metric Tons)[1]

Country	1932	1933	1934
Australia:			
New South Wales	5,199	9,512	15,902
Queensland	132	152	42
South Australia	117	205	208
Victoria	29	6	26
Austria	134,409	164,331	258,382
Canada[2]	2,833	27,158	[3]
China (Manchuria)	55,386	71,376	[3]
Czechoslovakia[4]	33,965	49,935	58,235
Germany	[3]	[3]	11,010
Greece	44,699	44,719	70,388
India, British	14,087	15,450	15,215
Italy	460	2,187	1,100
Norway	1,311	2,007	2,500
Southern Rhodesia	14	.....	.....
Turkey	310	951	628
Union of South Africa	1,418	1,495	1,667
U.S.S.R. (Russia)	334,454	380,300	482,000
United States	34,892	98,145	91,601
Yugoslavia[5]	33,317	14,602	25,086

[1] Unless otherwise stated, quantities in this table represent crude magnesite mined.
[2] Magnesitic dolomite.
[3] Data not available.
[4] Exports, less imports, of crude and sintered magnesite, the sintered magnesite being reduced to crude on the basis of 2.1 tons crude to 1 ton sintered.
[5] Serbia only.





Commercial manganese ores are chiefly the oxides that have either been deposited in commercially pure form in sedimentary beds or have been concentrated by the action of surface waters on weathered manganiferous rocks from which the impurities have been dissolved and carried away.[1] The lower limit of most deposits is above the level of the ground water or within 150 ft. of the surface. Some large deposits were laid down in lakes or marine estuaries. Manganese ores are classified commercially or for industrial purposes as follows: (1) iron ores, if containing less than 5 per cent manganese; (2) Manganiferous iron ores, if containing 5 to 40 per cent manganese; and (3) manganese ores, if containing not less than 40 per cent manganese.

Before the World War, Russia, supplying 50 per cent, and India, supplying 40 per cent, were the world's largest producers of manganese. In the latter part of the war, Russia virtually ceased production, and India, Brazil, and the United States became the chief producers. The war upset the trade and resulted in the opening of the deposits of Gold Coast and Egypt. More recently, the deposits of Transvaal in the Union of South Africa have begun producing. The development of new deposits has increased until the threat of over-production is very serious.

[1] HEWETT, D. F., Manganese in sediments, in TWENHOFEL, W. H., Treatise on sedimentation, Baltimore, 1932, pp. 562–581.

The principal consuming countries lack adequate resources, which necessitates importing most of the ore, as indicated by the import tables in Part II of this survey.

PRINCIPAL DEPOSITS

U.S.S.R. (Russia).—In the Union of Soviet Socialist Republics there are two manganese deposits of Tertiary age situated only a short distance from the Black Sea. The first of these, and the largest producer, is the bedded-type Chiaturi deposit of Georgia, where the ore runs 44 to 52 per cent manganese.[2] An American group made an unsuccessful attempt to exploit these deposits a few years ago. The second deposit is at Nikopol in southern Ukraine, where a lenticular bed 1 to 1½ m. thick occurs interstratified with Tertiary sediments.[3] The tenor of the ore is about 48 to 50 per cent manganese. The Russian ore requires washing before shipment and is in many instances too fine and soft to be used without mixing with the harder lump ores of India or South Africa.

British India.—Manganese deposits in British India occur in Bihar and Orissa, the Central Provinces, Madras, and Mysore. Of those mentioned, the Central Provinces and Madras are the largest producers. The Indian deposits are of four types: (1) Deposits composed of metamorphosed manganiferous sediments and characterized by the manganiferous silicates. These deposits are of large size and excellent quality, and some of those in the Central Provinces are among the most valuable in the world. (2) Deposits associated with a series of manganiferous intrusives typically developed in the Vizagapatam district of Madras. These ores may have been produced by the assimilation of manganese ore bodies or manganese silicates by molten granites to form manganese silicate minerals. Subsequent alteration has produced the secondary minerals. Manganese deposits of this type occur in Bihar and Orissa, Bombay, Central India, and the Central Provinces. (3) Lateritic deposits resembling laterite, occurring as replacements of schists, slates, and quartz-

[2] MARKOV, K. V., The Chiaturi manganese deposits *U.S.S.R. Geol. and Prosp. Serv., Trans.* No. 27, 1931, 41 pp. (Russian, English summary p. 41).

[3] NASILENKO, P. I., The Nikopol manganese ore district, in *Ukraine Inst. Geol.*, Useful rocks and minerals of Ukrainia, 1934, pp. 173–203 (Russian Engl. summary pp. 203–209).

ites. All stages of gradation from manganese to iron ore may be observed. The deposits are characterized by their high iron content, low manganese content (second-grade manganese ores and third-grade ferruginous manganese ores), low silica content, and very low phosphorus content. Such lateritic deposits occur in Bihar and Orissa, Bombay, Central Provinces, Madras, and Mysore, and in Gôa (Portuguese India). (4) Manganese ores of the true laterite type. These occur in Gôa where the production is very small.

Gold Coast.—The Nsuta-Dagwin deposits are the only manganese ores thus far exploited in Gold Coast. These pre-Cambrian ores occur as lenses composed of concretionary manganese minerals. As in the case of the Indian deposits secondary concentration by surficial agencies has formed large deposits. Only the secondary ores are being exploited. The property is leased to the African Manganese Co., Ltd., of London.

Japan.—During the World War the development and production of manganese in Japan were greatly stimulated. Increased activity in the iron and steel industry is again resulting in an expanding production of manganese. Manganese ore is quite widely distributed throughout Japan, but the workings are small and are conducted in a rather primitive fashion. The ore is mined chiefly on the Island of Hokkaido and near the town of Kyoto on Honshu Island.

Cuba.—There are large manganese deposits in northern Cuba; they are exploited by American capital, and the ore is shipped to the iron and steel plants of the United States.

Union of South Africa.—Very large deposits of manganese have recently been opened in the Postmasburg district of Transvaal,[4] Union of South Africa. Because of their location, transportation charges are comparatively high.

United States.—The manganese production of the United States remains small. Large reserves of low-grade ore are known, but high-grade deposits are few in number. Montana is the largest producer of high-grade manganese, followed by Virginia, Georgia, Arkansas, while Minnesota and Michigan are the largest producers of low-grade manganese ores.

[4] De Toit, A. L., The manganese of Postmasburg, South Africa, *Econ. Geol.*, vol. 28, No. 2, March-April 1933, pp. 95–122.

Brazil.—The most important manganese deposits of Brazil are those of Minas Geraes in the vicinity of Ouro Preto. Other high-grade deposits are situated in Matto Grosso.

Egypt.—Egyptian production of manganese comes from the Sinai Peninsula. The production has been small during the period 1932–1934. The tenor of the ore is approximately 32 per cent manganese and 26 per cent iron.

Philippines.—Production of manganese ore on Luzon Island of the Philippines began in 1934.

Other Countries.—Other countries producing a small amount of ore with a content of less than 30 per cent manganese are as follows: Argentina, Australia (New South Wales and South Australia), Chile, China, French Morocco, Germany, Greece, Hungary, Italy, Mexico, Netherland India (East Indies), Northern Rhodesia, Rumania, Spain, Sweden, Turkey, and Yugoslavia.

INDUSTRIAL USES

Manganese belongs to that group of elements which includes iron, cobalt, and nickel. It is never found in the metallic state in nature but generally occurs as oxide, silicate, or carbonate. In the modern methods of the production of steel, manganese is an essential element. Were industrial nations deprived of a supply of this element, they would have to modify greatly their practice in the manufacture of steel. More than 92 per cent of the world consumption of manganese is required to meet the demands of this industry.

The chemical properties of manganese make it essential in the manufacture of steel. Manganese prevents overoxidation of the steel by eliminating the oxygen in the bath (deoxidation) and eliminates part of the sulphur from the bath (desulphurization). It retards the formation of blow holes, renders the slag fluid, and adds the requisite amount of manganese desired in the finished steel. By far the largest tonnage consumed in this industry is used for deoxidation of the bath. In other words, it acts as a medicine upon steel.

Manganese in manganese steels ranges from 12 to 18 per cent. This range is due to the differences in the properties imparted to steel by minute changes of manganese content. Manganese steels are hard without being brittle and are malleable, although difficult to machine. These qualities make high-speed methods

of rail transportation possible. If rails and locomotive tires were not manufactured with a certain percentage of manganese, other metals might be used at an increase in cost but probably would not give the same degree of efficiency.

The difficulty of producing metallic manganese and the rapidity with which it oxidizes have prohibited its use in the metallic form. In the manufacture of steel it is introduced into the bath in an alloyed form, such as ferromanganese, spiegeleisen, and silicospiegel. The characteristics imparted to steels by the introduction of manganese give to them qualities adaptable to uses where a high degree of resistance to abrasion either by friction against smooth hard surfaces or against hard, brittle, angular materials and resistance to shock are required. Some of the articles now in common use that are manufactured from these steels are gears, pinions, sprockets, chains, dies, liners, wearing plates, rolls and rollers, railway frogs and switches, locomotive tires, and the crushing faces and digging parts of crushing and pulverizing machinery, such as plates, dies, rollers, and stamp-mill shoes. In the manufacture of some of these articles, manganese steel is practically the only alloy available, but for the making of others, it is no more desirable than some other alloys, such as those of chromium, vanadium, and tungsten, with which it must compete at current prices.

In the manufacture of dry cells, pyrolusite (MnO_2) is used, not for the manganese content but on account of the contained available oxygen. This mineral when absolutely pure contains 36.8 per cent oxygen, of which 18.4 per cent is available. Dry cells make possible the use of many of the electrical conveniences of everyday life.

Manganese dioxide, or pyrolusite, is also used in decolorizing glass and as a drier in varnishes and paints. Salts of sodium or potassium, when combined with manganates, yield sodium or potassium permanganates. These salts are powerful disinfectants. They are germicidal, as they are strong or powerful oxidizers.

SUBSTITUTES

There is no known substitute for manganese in the manufacture of steel. For the minor uses of manganese many substitutes are available, although no satisfactory substitute has been found for manganese dioxide in the manufacture of dry cells.

WORLD PRODUCTION OF MANGANESE ORE, 1932–1934
(In Metric Tons)

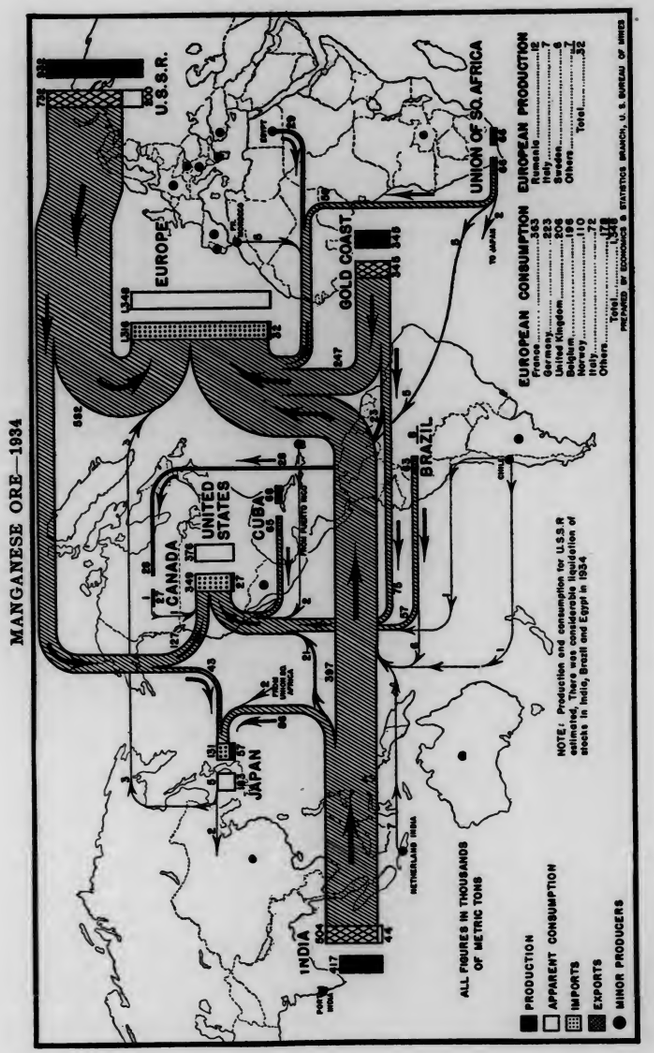
Country[1]	1932	1933	1934
Argentina[2]	252	410	583
Australia:			
New South Wales	108	131	105
South Australia	20	2	2
Brazil	20,300	25,000	7,527
Chile[3]	448	765	4,065
China[3]	20,733	9,574	870
Cuba	9,800	28,000	68,000
Egypt	327	187	959
Germany	12	563	515
Gold Coast[3]	51,502	269,395	344,832
Greece	745	1,628	1,206
Hungary	1,497	6,232	10
India:			
British	216,016	221,811	412,827
Portuguese	3,573	1,600	3,800
Italy	378	4,524	6,941
Japan	26,242	43,535	57,165
Mexico	700[4]	573	664
Morocco (French)	3,980	4,800	3,407
Netherland India (East Indies)	8,287	10,463	11,635
Northern Rhodesia	.....	5,453	2,074
Portugal	.....	26	295
Rumania	5,051	2,774	12,057
Spain	2,591	2,834	3,796
Sweden	3,014	5,895	5,832
Turkey	2,800	7,700	2,687
Union of South Africa	.....	21,229	57,730
U.S.S.R. (Russia)	915,300	998,000	1,821,000
United States:			
Continental (exclusive of fluxing ore)	18,062	19,453	26,940
Puerto Rico[3]	2,339	1,664	1,738
Yugoslavia	160	535	1,103
Total	1,314,000	1,695,000	2,861,000

[1] In addition to the countries listed, Belgium is reported to produce a small quantity of manganese ore, but statistics of output are not available. Czechoslovakia reports a production of "manganese ore," but as it has been ascertained that the product so reported averages less than 30 per cent manganese and, therefore, would be considered ferruginous manganese ore under the classification used in this report, the output has not been included in the table.

[2] Shipments by rail and river.

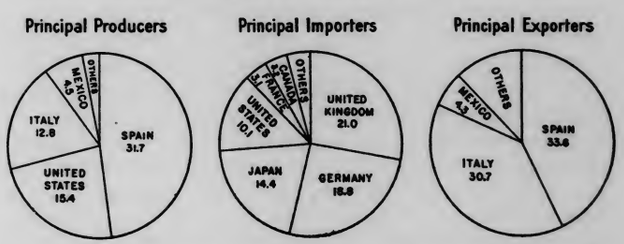
[3] Exports.

[4] Approximate production.



MERCURY — 1934

(all figures in thousands of flasks.)



Most mercury[1] ores are of rather simple mineral composition. About 25 mercurial minerals are known, most of which are rare, and some contain mercury only as a minor constituent. More than 95 per cent of the present world production of metallic mercury is derived from the distillation of cinnabar [the sulphide of mercury (HgS)], and rarely from native mercury or the chloride of mercury, calomel. The ordinary ores range from 0.3 per cent to 1 per cent mercury, with 0.5 per cent marking the line between poor and ordinary ores. Recovery in well-operated plants is about 95 per cent of the assay value. Mercury ore deposits consist of veins, disseminated crystals in the country rock, and notably irregular masses. Many deposits occur along lines of fissuring, often marked by hot springs. The ores seem to have crystallized at shallow depths and during volcanic activity at low temperatures and pressures. The deposits are therefore confined to rocks of no particular type or age, ranging in the latter case from Silurian to Pliocene. As a rule the ores do occur near the surface. The porosity of the rock determines the amount of cinnabar that may be deposited and consequently the tenor

[1] SCHUETTE, C. N., Quicksilver, *U. S. Bur. Mines, Bull.* 335, 1931, 168 pp.; The occurrence of quicksilver ore bodies, *Trans. A.I.M.M.E.*, 1931, pp. 403–488.

TROEGEL, H., Ueberblick über Vorkommen und Verhüttung des Zinnobers, *Metall und Erz*, vol. 27, No. 10, May 15, 1930, pp. 253–258.

of the ore. The formation of the mercury ore bodies seems to be often localized beneath structural traps formed by impervious horizons. Silica, either crystalline or opaline, calcite, and bitumen occur as gangue minerals. Pyrite and marcasite are common constituents.

The ores of mercury mined in the United States, unlike most other metals that are won by smelting, are treated at the mines, and the liquid metal is shipped as a finished commercial product in iron flasks containing 76 lb. each. Two kinds of reducing apparatus are used: (1) In the furnace method, the ore is directly exposed to the action of the flame; the volatile products of combustion, with more or less dust, sulphur vapors, and mercury, are driven out of the ore, and all pass together through condensers. The operation is continuous. (2) In the case of retorts, the ore is heated in a closed vessel away from the flame, and only the volatile constituents that are released from the ore, chiefly mercury and sulphur, pass into the condensing apparatus. In most retorts the operation is intermittent.

Before 1928 the mercury market of the world might have been considered highly competitive. At this time the International Cartel or the Consorzio Mercurio Europeo, with headquarters at Lucerne, Switzerland, was formed by an agreement between the Spanish and Italian Governments. In 1932 Italy threatened to withdraw, but in 1933 the agreement was renewed until December 1934, at which time it was prolonged for another 2 years. Meetings are held annually, and the world quotas and markets are allocated. The European market is supplied by Italy, and the rest of the world's supply comes principally from Spain.

Mercury mining is a small tonnage operation that is conducted by means of open cuts or by underground mining. Few mines have large tonnages of broken ore at any time. The mining operations, being relatively simple and located at the surface, render it easy for a fair number of operators to produce ore independently and easily when the price warrants. The smelting process is likewise cheap and fairly easy.

PRINCIPAL DEPOSITS

Spain.—In 1933 Spain became the largest producer of mercury, surpassing the production of Italy. The principal mercury mine

in Spain is the Almaden in the Province of Ciudad Real, 125 miles southwest of Madrid. Mercury is also produced in the provinces of Oviedo and Granada. The Government-owed Almaden mine is also the largest mercury mine in the world and has held this position since the beginning of mercury mining, a unique record among mines. The ore is found in sandstone interbedded with shale.

Italy.—The Idria mercury mine, located about 28 miles northeast of Trieste in Italy, has had a long and varied history. The mine, formerly owned by the Austrian Government, became the property of the Italian Government in 1918. The ore bodies are located at the junction point of intersecting fracture zones.

Another Italian mercury district that has been worked intermittently since the Greco-Roman period is that of Monte Amiata in the Province of Siena (Tuscany). For a long time the mines were closed. Operations were hindered by individual ownership of land. The deposits are situated along a pronounced fracture zone in a volcanic region. The deposits are inclined to be erratic and in general low grade. Extensive exploration and geological studies were required to reveal the unsuspected large and rich deposits.

United States.—The United States has a number of mercury districts in Arkansas, California, Nevada, Oregon, Texas, Utah, and Washington. California is the principal producer of mercury, the most important counties being Lake, San Luis Obispo, and Sonoma. Chief producing counties of Oregon are Jefferson, Lane, and Malheur. The Texas production comes from the Terlingua district. Pike County, in southwestern Arkansas, is a new producing district.

Mexico.—Mexico is not a large producer of mercury in spite of the various governmental inducements that have been offered from time to time. The largest mercury mines are those of Gadalcazar in San Luis Potosí.

Czechoslovakia.—Mercury is produced in Slovakia and the Russian sub-Carpathian region of Czechoslovakia.

Bolivia.—Bolivia reports small amounts of mercury.

China.—The most important mercury deposits of China are those of Kweichow Province and adjacent regions in Szechwan, Hunan, and Yunnan provinces. The cinnabar deposits occur

along more or less parallel zones. Picked ore runs 1.7 to 4.4 per cent mercury. Mining and smelting methods are very primitive.

Australia.—Production of Australia (Queensland) has been quite intermittent.

Peru.—Peru is no longer a producer, but it should be noted that the Huancavelica deposit, once one of the largest in the world, has supplied over 1,500,000 flasks.

U.S.S.R. (Russia).—The Union of Soviet Socialist Republics has one important source of mercury near Nikitovka in the Donets coal basin of the Ukraine. Cinnabar occurs in a sandstone beneath a dense shale horizon. Production has been intermittent. Prospecting for mercury ores is now being actively fostered in Soviet Russia.

Germany.—Mercury-bearing ores of Germany occur near Obermoschel in the Rhine Palatinate (Pfalz). These mines were operated at one time, but it is impossible to compete with the output of the present Italian and Spanish mines. The ore is exceedingly low grade, averaging 0.2 per cent, but the reserves are said to be large. It is reported that the Reich Government will grant subsidies or make guarantees against financial losses sustained by the operating company.

Other Countries.—A small amount of mercury is produced in Japan, New Zealand, Rumania, and Turkey.

Marketing.—The great mercury market of the world is London. Most of the Spanish mercury and much of the Italian production are sold there. A considerable part of the California mercury is handled by agents or brokers in San Francisco but the greater part is sold in New York. Most of the Mexican metal also goes to New York.

INDUSTRIAL USES

Mercury is the only common metal that remains liquid when subjected to a wide range of ordinary temperatures. This characteristic qualifies it for certain uses for which there are no known complete substitutes.

By far the largest part of the mercury consumed is utilized in the drug and chemical manufactures, fulminates, vermilion red, antifouling paint, mercury-vapor light, electrical apparatus, felt manufacture, gold and silver mining, and instruments, such as thermostats.

Calomel and corrosive sublimate are the most important drugs. Fulminate is used as a detonator for high explosives and in percussion caps and primers for the ignition of explosives necessary in the mining industry.

For many years mercury has been used in antifouling paints to prevent the collection of barnacles on ship bottoms. The mercuric oxide contained in these paints comes in contact with salt water, forming mercuric chloride or corrosive sublimate, and this poison kills the barnacles. In electrical apparatus, the principal consumption is in the use of mercury-arc rectifiers; and of less importance is the use of mercury in the manufacture of electric-refrigerator control apparatus, electrical switches, thermostats for oil burners, and for the automatic control of electric motors.

Mercury has been used extensively for some time in the recovery of gold and silver because of the readiness with which mercury amalgamates with these metals. The consumption of mercury in this use has been curtailed materially with the advent of the newer processes such as cyanidation and flotation. The amount of mercury used in the manufacture of thermometers and scientific instruments is extremely small.

The use of the mercury-vapor boiler for generating power is of great potential importance. The high efficiency and low cost of power and the small space required for these plants is notable. About 3½ lb. of mercury per horsepower is required. Several commercial installations have already been completed. Approximately 10,000 flasks of mercury are now being used in commercial power plants.

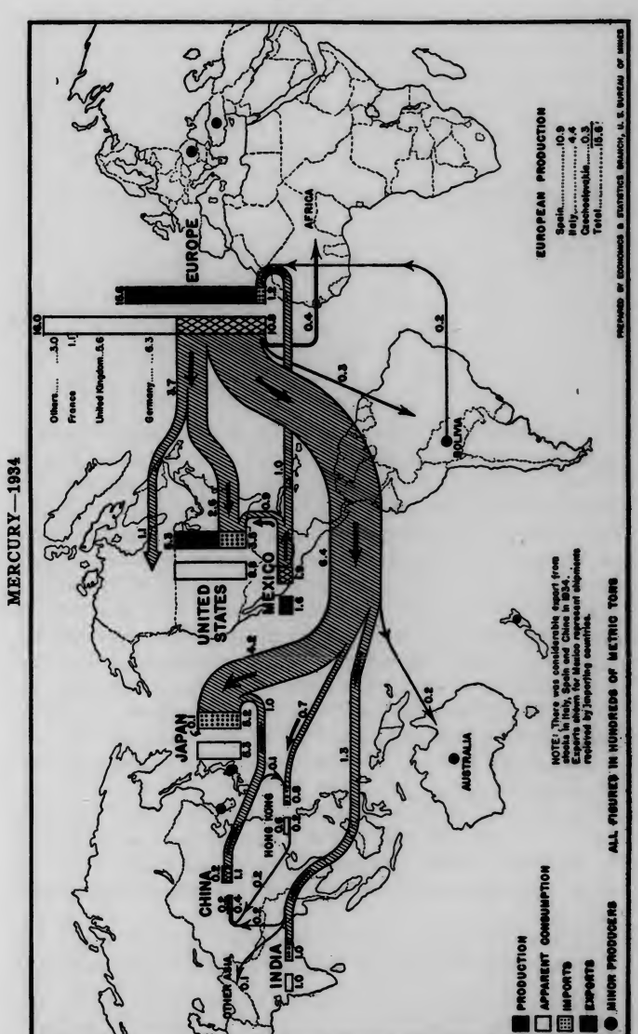
SUBSTITUTES

As has been stated, owing to its characteristic of remaining liquid within a wide range of ordinary temperatures, there are few substitutes for this metal. It has been suggested that detonators in which lead and silver form the principal component may be used as a substitute for mercury fulminate.

WORLD PRODUCTION OF MERCURY, 1932–1934
(In Flasks and Metric Tons)[1]

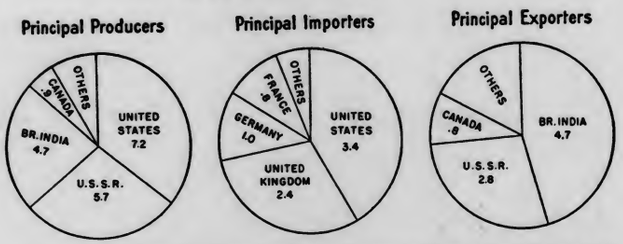
Country[2]	1932		1933		1934	
	Flasks	Metric tons	Flasks	Metric tons	Flasks	Metric tons
Algeria	1,184	40.8	.....	.....	.....	.....
Australia (Queensland)	26	0.9	.....	.....	3	0.1
Austria	23	0.8	5	0.2	.....	.....
Bolivia[3]	505	17.4	.....	.....	664	22.9
Chile	8	0.3				
China[4]	580	20.0	435	15.0	[5]	[5]
Chosen	26	0.9				
Czechoslovakia	1,305	45.0	194	6.7	763	26.3
Italy	29,480	1,016.3	17,605	606.9	12,804	441.4
Japan	69	2.4	234	8.1	196	6.8
Mexico	7,330	252.7	4,478	154.4	4,580	157.9
New Zealand	20	0.7	99	3.4	49	1.7
Rumania	2	0.1	8	0.3	2	0.1
Spain	23,656	815.5	19,626	676.6	31,799	1,096.2
Turkey	.....	.....	23	0.8	41	1.4
United States	12,622	435.1	9,669	333.3	15,445	532.4
Yugoslavia	8	0.3	.....	.....	.....	.....
Totals	76,844[6]	2,649.2[6]	52,376[6]	1,805.7[6]	66,800[6]	2,300.0[6]

[1] One metric ton = 29.008 flasks of 76 lb.
[2] In addition to the countries listed the U.S.S.R. is reported to produce mercury, but no statistics of production are available.
[3] Exports.
[4] Approximate production (Imp. Inst., London).
[5] Data not available; estimate included in total.
[6] Exclusive of U.S.S.R. (Russia).



MICA – 1934

(all figures in thousands of metric tons)



Commercial sheet mica[1] is of two mineral varieties, known as muscovite and phlogopite. These minerals are found only in certain coarse-grained dike or vein rocks called pegmatites. The mica-bearing pegmatites are generally to be found in gneisses and schists, representing historically the very oldest of rocks. As earth movements that involved mica-bearing dikes would have bent and crumbled the sheets of mica and rendered them commercially worthless, the areas in which commercial mica is found must have been unusually stable geologically, and the dikes must have withstood without deformation all folding and faulting that may have taken place after they were formed. In only a few regions does the earth's crust fulfill these conditions, and, therefore, although mica is one of the commonest minerals, forming a part of nearly all rocks, commercially valuable deposits are extremely rare.

Sheet mica may be concentrated in one or more well-defined layers or bands, generally near the edges of the pegmatite dike, or the mica may be scattered irregularly through the dike in clusters or lenses; more often it is slightly concentrated in the rock.

An important trend in the mica industry is the great increase in the amount of finely divided mica obtained from the washing of

[1] Mohr, H., Der Nutzglimmer, Natur, Vorkommen, Gewinnung, Verwendung, Berlin, 1930, 275 pp.

kaolin or from mica schists. Only a few years ago almost all ground mica was made from the scrap or waste produced in trimming sheet mica. In the United States in 1935 the true scrap provided only 65 per cent of the total output of ground mica.

PRINCIPAL DEPOSITS

United States.—The United States is the world's largest producer as well as consumer of mica. The United States produces 15 to 35 per cent of its requirements of sheet mica but is self-sufficient in regard to scrap mica. Over three-fourths of the sheet mica is supplied by North Carolina and New Hampshire. The remainder of the domestic mica comes from Colorado, Connecticut, Georgia, Maine, New Mexico, and South Carolina.

U.S.S.R. (Russia).—The chief mica-producing region of the Union of Soviet Socialist Republics centers in the greater Lake Baikal region of Siberia. Here in the Irkutsk district are to be found the Slyudyanka phlogopite deposits which contribute about three-fifths of the total Soviet output. The muscovite deposits of the Mama River have been mined since the eighteenth century and today produce about one-third of the total output of the U.S.S.R. There are smaller deposits in the Kansk district. A number of mica-bearing pegmatites occur in central Karelia, the administrative district north of the city of Leningrad.

India.—Virtually all of the mica extracted in India is muscovite. The mica is produced chiefly from Bihar and Orissa and a smaller amount from Madras. Some mica is also produced in the Ajmer district of the Province of Rajputana. The production is, however, chiefly centered about the Hazaribagh district in Bihar and the Nellore district in Madras. The mica from Bihar is exported from Calcutta, the Madras mica is exported from the port of Madras, while the production from Rajputana is exported from Bombay. The mica deposits occur in pegmatite dikes, exploited alike by primitive and modern practices. Almost all of the mica produced and prepared as cut mica or mica splittings is exported. If one compares the recorded mine production and the exports it will be seen that the exports are considerably greater in volume and especially greater in value than the mine production. This discrepancy is due to the illicit losses occurring during the transportation of the mica from the mines. Of late years

laws have been passed to restrict illegal trade in mica. Thefts have been reduced, but lack of funds prevents adequate enforcement of the laws. Although the tonnage of mica produced is less than that of the United States, the value is much greater, owing to the large volume of low-grade mica powder or micanite produced in the United States. The preparation of sheet mica requires a great amount of cheap hand labor, and in this regard India has an advantage.

Canada.—Phologopite mica is produced in Canada from the pegmatites north of Hull in Quebec, and in Ontario in a district about 50 miles square in North Burgess Township around Perth, and in Loughborough Township around Sydenham.[2] Formerly the mica was sold in a semirough form called "thumb-trimmed," but this practice has been replaced by knife trimming, producing a higher-grade product. Small-size mica was formerly recovered from old mine dumps, which are now practically exhausted.

Union of South Africa.—Mica mining is a recent development in the Union of South Africa. The muscovite is mined in the Leysdorp field in the Pietersburg district in a belt 2 to 4 miles wide and 50 miles long. The mica is largely of the scrap grade.

Madagascar.—Important commercial deposits of phlogopite in Madagascar are found in the vicinity of Fort Dauphin and the Province of Betroka, chiefly in the former district. Production of phlogopite mica has greatly increased in recent years, though the muscovite production shows little change. Madagascan and Canadian deposits are similar in occurrence. Climate, lack of transportation, and labor conditions militate against more intensive development of the region. The majority of the deposits are controlled by one company, the Société des Minérals de la Grand Ile, which consolidated the holdings of the more important deposits in 1926.

Numerous mica deposits, chiefly of the muscovite variety, are reported in the high plateau region forming the central part of the island, especially near Lake Alaotra. These deposits are more deeply weathered than the southern deposits, hence the mica is more easily and cheaply recovered.

Norway.—Mica-bearing pegmatites have been worked in the Skutterud district of southwestern Norway. The crystals were small, impure, and had an imperfect cleavage surface. Mica,

[2] SPENCE, H. S., Mica, *Can. Dept. Mines, Mines Branch, Pub.* 701, 1929, 142 pp.

produced as a small household industry, is obtained from a number of other localities.

Argentina.—At the time of the World War the mica industry of Argentina grew from almost insignificant proportions to about its present level. The chief productive pegmatites occur in the Provinces of Córdoba and San Luis.

Australia.—New South Wales is the principal producer of mica in Australia. The mica-bearing pegmatites are found in the Broken Hill district. In the Northern Territory mica is produced in the MacDonnell Range in the vicinity of Mount Palmer.

Tanganyika Territory.—Tanganyika Territory has deposits of very high grade mica in the Uluguru Mountains.

Southern Rhodesia.—Production of mica in Southern Rhodesia is confined to the Lomagundi district.

Northern Rhodesia.—Mica deposits are worked in the Susaka district of Northern Rhodesia.

Other Countries.—A small amount of mica is produced in Bolivia, Brazil, Ceylon, Chosen, Eritrea, Italy, and Sweden.

INDUSTRIAL USES

The industrial importance of mica was clearly portrayed during the World War. Germany was deprived of its principal sources of supply and was forced to the discovery of a substitute for the manufacture of magnetos and radio condensers. No satisfactory material was found to replace mica for certain electrical needs where dielectric strength, power factor, resistance to heat, and flexibility are the important characteristics required.

The most important industrial use of mica is for electrical insulation. As an insulator for certain types of electrical equipment only high-grade phlogopite is adaptable. In no other substance are found the qualities possessed by mica. It is not only one of the best-known insulators from the standpoint of resistance to electrical puncture, fusion, and almost perfect impregnability to moisture, but the physical qualities of toughness, elasticity, and flexibility place it in a class by itself.

In the manufacture of armatures for electric motors, mica has been found to be most satisfactory for separating the copper segments of the commutators. Its high dielectric strength is the characteristic desired in this adaptation, and only high-grade mica free from iron impurities, holes, or cracks can be used.

Mica sheets of many shapes enter into the manufacture of fuse boxes, electric light sockets, electric heaters, flatirons, telephones, and spark plugs.

As a heat-resisting, transparent medium, it has many diversified uses, such as for stove doors, windows, furnace sight holes, heat screens, lamp chimneys, canopies, shades, etc.

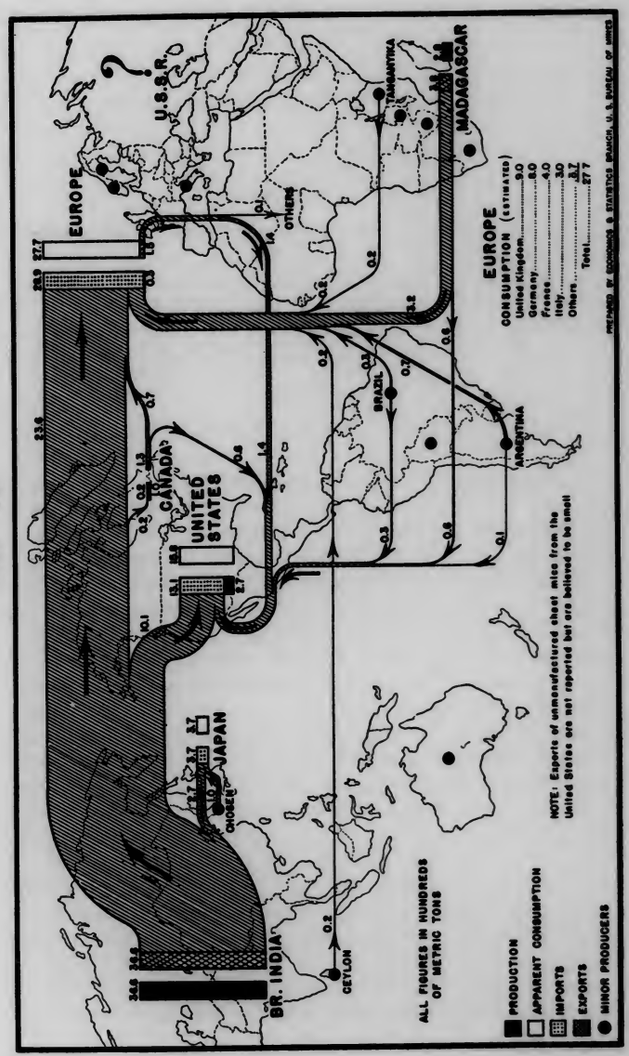
SUBSTITUTES

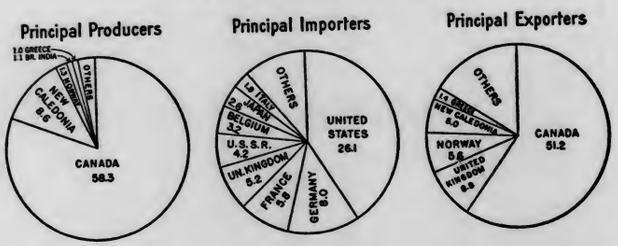
For nonessential and therefore nonelectrical uses, substitutes are known. For certain electrical requirements, pertinax, developed by Germany during the World War, is a part substitute in high-tension condensers, but as a substitute for high-quality mica, pertinax has comparatively little importance.

WORLD PRODUCTION OF MICA, 1932–1934
(In Metric Tons)

Country	1932	1933	1934
Argentina[1]	55	75	175
Australia:			
New South Wales	.....	41	91
Northern Territory (Central Australia)	30	43	49
Bolivia[2]	8	23	4
Brazil[2]	42	23	59
Canada (sales)	280	857	905
Ceylon[2]	2	[3]	[3]
Chosen	20	23	103
Eritrea	20	[3]	[4]
India, British[5]	2,389	2,878	4,716
Italy	9	3	5
Madagascar[6]	140	173	294
Norway[2]	103	105	170
Rhodesia:			
Northern Rhodesia	.....	2	1
Southern Rhodesia	13	4	2
Sweden	61	68	16
Tanganyika Territory	12	11	31
Union of South Africa (Transvaal, sales)	250	549	278
U.S.S.R. (Russia)	7,790	5,778	[4]
United States (sales)	6,540	8,104	7,267

[1] Rail and river shipments.
[2] Exports.
[3] Less than 1 ton.
[4] Data not available.
[5] Exports. The figures for output are incomplete, and a more accurate idea of the size of the industry is to be obtained from the export figures (*Rec. Geol. Survey India*, vol. 59, pt. 3, 1926 p. 273). Output is reported as follows: 1932, 1,662 tons; 1933, 2,087 tons; 1934, 2,830 tons.
[6] Exports reported as follows: 1932, 130 tons; 1933, 246 tons; 1934, 380 tons.





Two classes of deposits are mined for nickel: (1) Ores mined in the zone of oxidation. Genthite, a nickel-magnesium silicate formed by the oxidation and disintegration of serpentines and similar igneous rocks, is the principal mineral component of such ores. Deposits of this type are best developed in the warm, humid regions of the tropics and are well exemplified by the deposits of Brazil and New Caledonia. The form or outline of such an ore body is that of a blanket occurring widespread over the parent rocks. (2) Ores of the sulphide zone, composed essentially of pyrrhotite carrying small quantities of pentlandite, a nickel-iron sulphide. The pyrrhotite also carries small quantities of copper, platinum, selenium, and tellurium. Some veins carry these sulphides, but a more common occurrence is that of huge lenses or masses of pyrrhotite which have crystallized or become segregated from molten rock or have replaced the older rocks themselves. At Fredericktown, Mo., nickel was once mined from ores occurring in sedimentary rocks. The ores also carried the sulphides of zinc, lead, copper, and cobalt. Small quantities of nickel are recovered in the electrolytic refining process when applied to certain copper ores. In certain places serpentine itself occurs as large bodies carrying a small percentage of nickel too low in grade to be profitably mined.

PRINCIPAL DEPOSITS

Canada.—Nickel ores occur in the Sudbury district and Pigeon River region, Ontario, and near Hope, British Columbia. Of these, Sudbury is the only producing district, and it is also the world's chief source of this metal. The Sudbury sulphide ores were discovered many years ago and were first mined for copper. In addition to nickel and copper, an important production of gold, the platinum group—selenium, silver, tellurium, and other metals—is now recovered from this area. These deposits occur as great sulphide lenses and irregular bodies along the lower side of a great, trough-shaped igneous intrusive, and two companies are actively engaged in exploiting them. The nickel is smelted in Canada and refined in Canada, Wales, and Norway.

The Nickel occurs as the mineral pentlandite. Reserves of the district are sufficient to supply the world for many decades to come. The ore runs up to 2 or 3 per cent nickel and 2 per cent copper.

New Caledonia.—Long-continued weathering of the igneous rocks of New Caledonia has resulted in a surface concentration of nickel silicate minerals over a wide area. The tenor of the ore runs 4.5 to 6 per cent nickel. The ores are subjected to a preliminary smelting and then exported to France and Belgium for further refining. One French company and several Japanese concessionaires are producing from some of these deposits. With the exploitation of the richer New Caledonian ores in the latter half of the last century, small deposits in Austria, Germany, Hungary, Italy, Norway, and Sweden were closed.

Greece.—Nickel ores are produced in Locris and Boetia, Greece, from occurrences associated with serpentines as chromiferous iron ores bearing 0.1 to 1.2 per cent nickel. The greater part of ore is shipped to Germany for smelting and refining.

Norway.—Over 40 nickel-bearing localities are known in Norway, but all the mines are small. The ores occur under geological conditions similar to those of Sudbury, Ontario, and carry about 1 per cent nickel. The most important deposits are those of the Evje and Hosanger districts. An important nickel smelter at Kristiansand refines some matte imported from the Sudbury (Ontario) district.

British India.—The Burma Corporation, Ltd., of British India produces a speiss composed of about 25 to 30 per cent nickel and

varying percentages of copper, silver, and cobalt from its deposits in the Northern Shan States. The speiss is exported to Hamburg, Germany, for further treatment.

U.S.S.R. (Russia).—Nickel ores of the Union of Soviet Socialist Republics occur in the vicinity of Orsk and Aktubinsk in the Ural Mountains. In 1933 a refinery was completed at Ufaley with an initial annual capacity of 3,000 tons of ferronickel. In 1935, another plant with an annual productive capacity of 500 tons of metallic nickel was begun at Orsk. Plans are being considered for the construction of small nickel plants in the Kola Peninsula and in the Norilsk district, Siberia.

United States.—Nickel-bearing ores occur in the United States in Lancaster County, Pa., at Mine La Motte, Mo., in southern Montana, and on Admiralty Island in southeastern Alaska. None of these deposits is now being worked. Present production of nickel is in the form of nickel salts recovered as a by-product of copper refining. The United States, the principal consumer of nickel, thus depends on imports for its supply.

Brazil.—Nickel reserves of the New Caledonian type are being developed in Brazil.[1] Owing to the high cost of transportation the ores will be given preliminary treatment in Brazil.

Union of South Africa.—In the Union of South Africa, nickel ores of the Sudbury type are being developed in the Rustenburg district, Transvaal.[2]

Other Countries.—Nickel ores are also reported to occur in the Celebes Islands, Tasmania, and Finland.

INDUSTRIAL USES

The use and consumption of nickel, particularly as an alloy in armor plate, reached record heights during the World War. Since then, the industry, through its research efforts, has widened the base of its industrial applications. Today peace-time applications of nickel exceed its former military uses.

Progress in the use of nickel as a metal is reflected in the following summary of applications that have fostered increased demand. (1) The production of stainless steels, particularly

[1] MORAES, L. J., Nickel no Brasil, *Serviço de Fomento da Producçao Mineral, Bol.* 9 (in Portuguese), Rio de Janeiro, 1935, 168 pp.

[2] SCHWELLNUS, C. M., The nickel-copper occurrence in the Bushveld Igneous Complex west of the Pilandsbergen, *Union of South Africa Dept. Geol. Series, Bull.* 5, 1935, 36 pp., 9 figs.

for railway construction, is increasing. Nickel-bearing aluminum alloys are becoming more important in this field. (2) Nickel-alloy cast irons are assuming greater importance. Common gray cast iron cannot stand the speed, stresses, and strains of present industrial activity. When nickel is added to cast iron the latter is strengthened, stiffened, and hardened. (3) The combination of nickel with tin in the bronzes of the structural grades has improved their mechanical properties and lowered their cost. (4) The increased application of welding in structural work and manufacturing has led to the development of nickel-steel and monel-metal welding rods. (5) Nickel alloys that are resistant to corrosion and are particularly adaptable to nickel plating have been developed.

Some outstanding recent industrial applications of the nickel alloys are as follows: Agricultural equipment employing nickel steels has been redesigned and is being used more extensively owing to the increased mechanization of the cultivation and harvesting processes. Food- and beverage-processing and display equipment utilizes increasing quantities of nickel, owing to its noncontaminating properties. Corrosion and contamination are serious problems in the chemical industry, which must market products of standard purity. Chemical manufacturers making especial use of nickel are the phenol caustic soda producers, noncombustible synthetic solvent producers, cosmetic firms, dye makers, and rayon plants.

In machine and motor manufacture the use of nickel and nickel alloys attains its greatest importance and has perhaps its greatest sphere of future expansion. Better grades of machines are being ordered now for replacement of obsolescent stock. Consumers are seeking more compact machinery of the most efficient design and improved performance, with greater freedom from breakdowns. Higher machine-operating speeds and the machining of harder metals have led to greater demands for nickel steels for stressed members or revolving parts as well as for use in such parts as frames and dies. The toughness of these nickel alloys has led to their use in hand tools.

In no field are greater demands placed on a metal than in the mining and petroleum industries, where materials must withstand corrosion, shocks, abrasion, fatigue, temperature changes, and heavy loads. Business as well as safety dictates that breakdowns

shall be reduced to a minimum. Among the many applications of nickel to the construction of mining supplies might be mentioned crushers, cars, mine skips, pumps, and drills. In the oil industry, the increasing depth of wells emphasizes the need for metals that can withstand increasing stresses and temperatures. In refining plants, nickel alloys are used in vessels for dewaxing lubricating oils, and in valve parts, pumps, bolts, and tubular equipment. Nickel continues to be used as a catalyzer in refinery procedure.

Nickel steel is utilized in the moving parts of heavy-duty transportation equipment, ranging from high-speed airplane engines to slow-moving diesels. Safety factors must be observed, but great reductions in weight are anticipated. Besides their use in moving and stressed parts, stainless metals are a feature of automobile, railway-car, and airplane appointments and hardware. Contact with salt water involves the particular problem of corrosion in marine transportation. Increased speeds and greater size of passenger ships require a larger supply of alloys.

Because of the variety and extent of public works and soil-conservation projects, large tonnages of nickel alloys are required in the machinery employed for the preliminary work of excavating and road-building as well as in the metal equipment used in the construction and operation of the various dams, bridges, tunnels, and sewerage and water-works systems.

Light-colored nickel alloys, because of their appearance and corrosion resistance, lend themselves to use as decorative materials in building construction. Modern decorative art features the light metals as signs and trimming material.

The development of nickel silver and bronzes has stimulated the use of rolled-nickel products. The radio industry, which uses rolled nickel in the manufacture of vacuum tubes, is an important consumer. Rolled nickel is also employed in the jewelry and optical trades.

New advances have been made in the art of nickel plating. Development of bright nickel enables irregular shapes to be plated and reduces the amount of buffing ordinarily required. Worndown parts of machinery and equipment are built up by means of nickel plating.

Nickel coins continue to maintain a prominent place in the monetary systems of many countries of the world. In addition,

the nickel in the coins forms a valuable source of nickel supply in times of national necessity. At present, over 4 billion pure nickel pieces, representing 77 denominations, have been struck; these were issued by 28 countries.

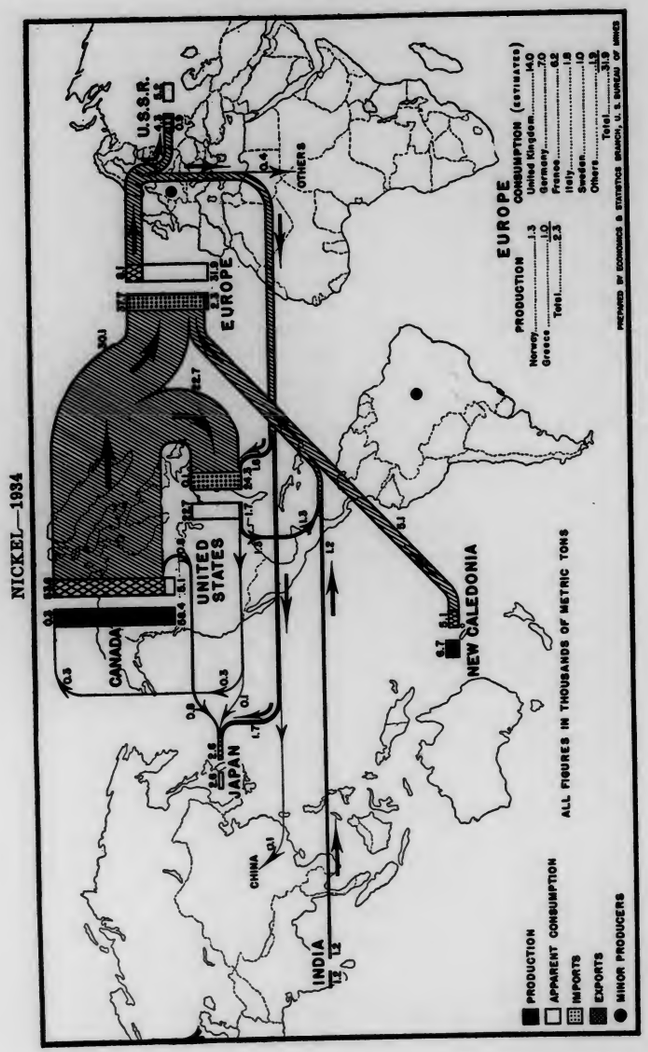
SUBSTITUTES

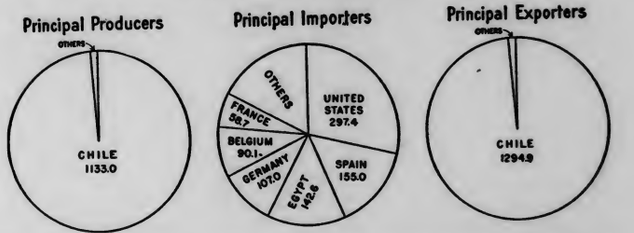
In the manufacture of certain grades of steel there is no known substitute for nickel. Such materials as armor plate, projectiles, and acid and weather-resisting alloys are dependent upon nickel in order to produce the satisfactory physical qualities. However, there is a German rustproof steel called "Roneusil," which contains 8 to 9 per cent chromium, 12 per cent manganese and no nickel. It is claimed that it is resistant to acids, is capable of taking a high polish, will not tarnish, and may be soldered or welded. In the manufacture of structural steel in which nickel is used, particularly for bridge purposes, molybdenum is said to be a satisfactory substitute.

WORLD PRODUCTION OF NICKEL, 1932–1934
(Metal Content in Metric Tons)

Country	1932	1933	1934
Australia (Tasmania)	1	9	.....
Brazil	.....	31[1]	39[1]
Canada	13,756	37,768	58,371
Greece	953	1,377	1,063
India, British	945	989	1,188
New Caledonia	5,000	5,000	8,600
Norway	975	969	1,334
U.S.S.R. (Russia)	.....	.....	863
United States	177	114	142
Total	21,807	46,257	71,600

[1] Approximate production.





Sodium nitrates[1] generally occur in nature mixed with sodium chloride and sodium sulphate, all combined with sand, gravel, clay, and fragments of rock. Most of the numerous deposits in different parts of the world are comparatively small and low-grade, their content of sodium nitrate ranging from a mere trace to perhaps 5 per cent; in fact, the only deposits of known value are those of Chile.

Potassium nitrate occurs in caves and on rock ledges where the remains and excreta of mammals and birds are the chief source of the organic matter. Such deposits are necessarily limited in extent and are exploited by small-scale, primitive methods to supply the needs of the area in which they occur.

PRINCIPAL DEPOSITS

The world's nitrate deposits, except those of Chile, though numerous are generally small. In no other mineral does such a natural monopoly occur as in the case of nitrate. This monopoly has been broken since the World War by the introduction of synthetic or artificial nitrogen.

Chile.—The Chilean deposits are found in a productive area of some 550 sq. km. in the Provinces of Tarapaca and Antofagasta.

[1] STUTZER, O., Die wichtigsten Lagerstätten der "Nicht-Erze," Phosphat-Nitrat, Berlin, 1932, pp. 295–390.

The deposits are on the lower portion of a westward-sloping desert plain, extending between the high Andes and the lower coastal ranges. These intermontane plains have been formed in geologically recent times by torrential rains, which have eroded and transported large volumes of detrital material into a long, narrow basin. Doubtless the formation of nitrate is continuing.

The nitrate deposits occur on the surface or are covered by a small amount of overburden. In addition to the rock detritus present, the nitrate is accompanied by sodium chloride, sodium and calcium sulphates and borates, and one valuable by-product —sodium iodate. These deposits are the most important source of iodine in the world. They carry 12 to 70 per cent sodium nitrate, but material carrying 25 per cent is commercial grade.

A number of theories have been advanced as to the origin of nitrogen, but none of them seems entirely acceptable. It may be that bacteria in the soil transformed the nitrogenous material into nitrates, which were concentrated by repeated leaching and evaporation. The grade of these deposits is to a great extent due to the aridity of the region.

Nitrate extraction methods have been very wasteful. Better methods have followed consolidation of companies, which was precipitated by the severe competition of artificial nitrate. The salts are dug from shallow pits, and the sorted material is taken by rail to the reduction works, where the salts are crushed, leached by boiling water, crystallized, and refined. Iodine is won as a by-product of this operation.

Stutzer[2] estimates the reserves of the deposits at 247,000,000 tons of material 1 ft. in thickness and carrying 11 per cent nitrate. The unprospected lands amounted in 1925 to 25,000 sq. km. Present estimates of reserves are higher than the earlier estimates.

United States.—Small deposits of nitrates are found in the United States in Idaho, southeastern Oregon, and Colorado.[3]

British India.—Nitrate earths are treated in several Provinces of British India. The technologic processes resemble those used in Chile, but are pursued on a smaller scale.

[2] STUTZER, O., Die wichtigsten Lagerstätten der "Nicht-Erze," Phosphat-Nitrat, Berlin, 1932, p. 372.

[3] MANSFIELD, G. R., and L. BOARDMAN, Nitrate deposits of the United States, *U. S. Geol. Survey, Bull.* 838, 1932, 107 pp.

INDUSTRIAL USES

Until the World War period, except for a small portion derived from by-product sources, natural Chilean nitrates supplied all industrial as well as fertilizer nitrogen throughout the world. With the development of synthetic processes for the production of nitrates, the importance of natural nitrates and the quantities used began to decline. At present, less than 10 per cent of the world's industrial and fertilizer nitrogen comes from natural nitrate. Approximately 60 per cent is derived by the extraction of nitrogen from the air by synthetic methods; the balance is obtained as a by-product, principally from the coking of coals.

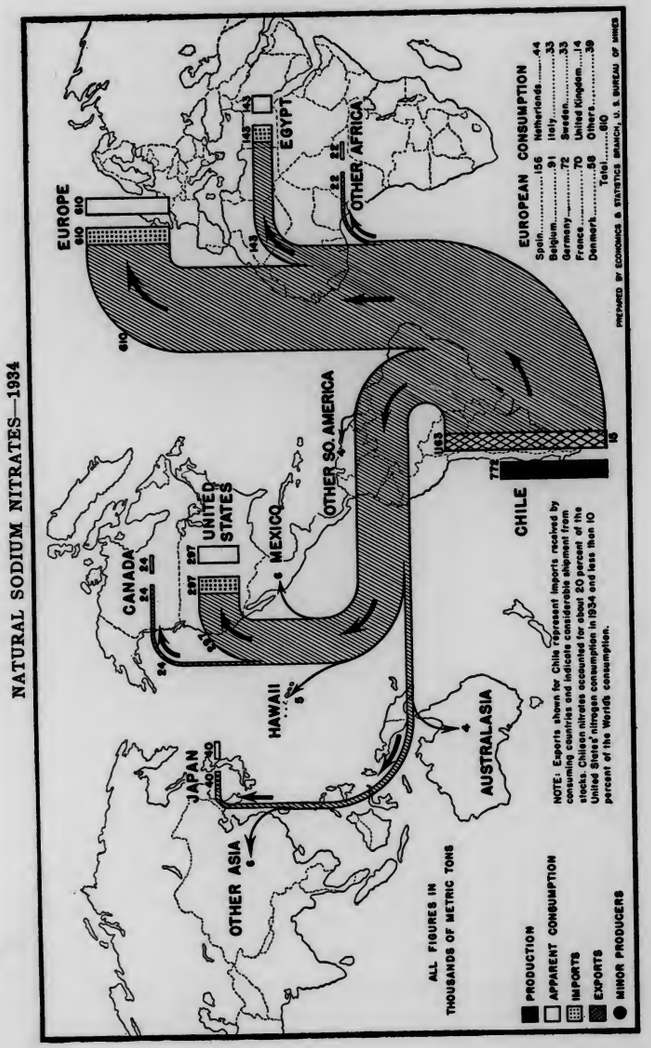
In earlier years there was little relationship between the cost of production and the sales price of natural nitrate. With the development of competitive material, however, not only the price declined, but also costs of production were lowered by technologic improvements, both from research and from the development of larger industrial units in Chile. Synthetic sodium nitrate can now be manufactured in America and Europe at a cost lower than the delivered cost of natural nitrate recovered in Chile. The continuance of Chilean operations is not inherently due to any economic advantage of the natural supply but is the result of world trade agreements. The installed capacity of synthetic plants, combined with the inevitable production of by-product nitrogen, is more than sufficient to supply the world's peak requirements, even in the event of extensive military operations. During 1935, synthetic plants of the world operated at approximately 60 per cent capacity.

Of the world consumption of nitrogen compounds, approximately 85 per cent goes into the fertilizer industry. During war times the manufacture of nitric acid for military use is second in importance as a consumer of industrial nitrogen compounds, but during peace times the manufacture of sulphuric acid, the manufacture of nitrogen chemicals, and commercial explosives, are far more important as nitrogen consumers than are military requirements. In all of these applications, synthetic ammonia and nitrates are interchangeable as primary sources.

SUBSTITUTES

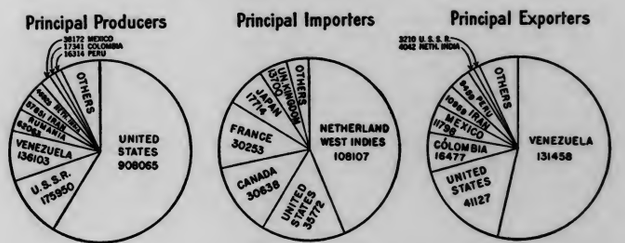
There are no known substitutes for the major uses of nitrogen and its compounds.

NATURAL SODIUM NITRATES—1934



PETROLEUM — 1934

(all figures in thousands of barrels)



Petroleum is at one end of a long series of mineral fuels ranging from the anthracites low in volatile compounds through the cannel coals and oil shales to the liquid fuel itself. Petroleum, a liquid bitumen, on exposure to atmospheric agencies is hardened to form gilsonite, ozokerite, and other solid bitumens. Petroleum shows a wide range in color, specific gravity, and content of volatile matters. It is a complex mixture of many compounds composed chiefly of carbon and hydrogen, but is generally classified according to two bases, the asphaltic and the paraffin, which are represented by asphaltic or paraffin residues, respectively, on distillation. Many oils contain both the asphaltic and paraffin bases. In general, the lighter, higher value oils are of the paraffin type and are used for lubricants and the production of gasoline. The heavier oils, with an asphaltic base, are used directly as mineral fuels or for the manufacture of heavy lubricants and petroleum asphalt.

Many theories have been proposed to explain the origin and concentration of petroleum. That petroleum is of organic origin there seems no doubt. Although decomposing animal matter may have been important in the production of certain high-grade oils, a more likely origin is that of the formation of the oil by small one-celled plants or diatoms. That petroleum is being deposited today is shown by the formation of oil and natural

gas about accumulations of decaying organic matter in brackish waters. This matter may be trapped or occluded by fine particles of mud and silt and produce oil shales as those of Estonia. In other areas, where the organic matter comes to rest in sands (sandstones), the movement of percolating waters may collect the oil droplets and transport them along porous strata to structural traps—such as unconformities, domes, and faults—where the petroleum continues to accumulate and in time may form a pool. Gravity segregates the lighter natural gas in the upper part of the pool and the heavier salt water below the oil. The presence of oil in a locality is often shown at the surface by springs and seeps.

Small producing areas are known as fields, while the oil deposit beneath is known as a pool. The term "pool" does not mean a subterranean lake but an accumulation of the petroleum in the interstices of the rock particles. A group of fields in one region is known as a district, while a number of districts may form a larger regional province.

PRINCIPAL DEPOSITS

United States.—The United States produces roughly 60 per cent of the world's petroleum. Texas is the largest producer, followed (1935) by California, Oklahoma, Kansas, Louisiana, New Mexico, Pennsylvania, Michigan, Wyoming, and Arkansas. The Appalachian district of Pennsylvania, New York, Ohio, West Virginia, and eastern Kentucky is the oldest producing district in the United States. The oil of this district has a paraffin base and includes some of the world's best lubricating oils. The oil occurs in anticlines, synclines, and certain of the more porous strata.

The Southern Illinois district includes southwestern Indiana, central and southern Illinois, and western Kentucky. The oil has been concentrated in small structural traps.

The greatest producing area of the United States and of the world, for that matter, is the Mid-Continent field, which includes Oklahoma, Kansas, and northern Texas. The oil occurs here in structural traps, at contacts or unconformities between formations, and in places where the strata are more porous, such as in the shoestring sands of eastern Kansas.

In the western Gulf Coast region of Louisiana and Texas, large deposits of oil are concentrated along faults and occur in close association with buried salt domes of Tertiary age. The Rocky Mountain oil province extends from Montana south to New Mexico, the largest deposits of oil being in central Wyoming and southeastern New Mexico.

On the Pacific Coast of southern California are many enormous deposits of oil in the folded Tertiary and Quaternary sediments. These oils have an asphaltic base. California oil dominates the fuel situation of the Pacific Coast territory of the United States.

U.S.S.R. (Russia).—The Union of Soviet Socialist Republics is the second largest producer of petroleum. Most of the oil comes from the region adjacent to the western coast of the Caspian Sea, particularly in the region about Baku, in the northern Caucasus region of Grozny, and in the Taman Peninsula near the Black Sea. The oil comes from Tertiary sediments under conditions analogous to those in the Gulf Coast of the United States. Recently oil-bearing formations have been discovered in the Tertiary deposits extending southward from the Ural Mountains and lying to the north of the Caspian Sea. On the Island of Sakhalin, both the Russians and the Japanese produce oil, the Japanese producing from concessions obtained from the Soviets. A small amount of oil is obtained in central Asia in the Tertiary and Cretaceous formations of the Kara Kum Desert and the Ferghana basin. Active prospecting is going on in the northern or Arctic region. Soviet Russia has been an important oil exporter; now, however, domestic consumption seems to be growing and limiting the amount of oil available for export. Despite strenuous efforts, the actual production has never attained the planned production. Many reasons are assigned for this, chief of which are the failure of materials used in drilling and refining, a high labor turnover, and faulty technique.

Venezuela.—The petroleum production of Venezuela comes largely from the Maracaibo basin, situated between two ranges of the eastern Venezuelan Andes. Oil seepages are numerous in the basin. The principal fields are along the east side of Lake Maracaibo, but some fields are also on the west side of the lake. The folded Cretaceous and Tertiary formations of the Orinoco basin have also yielded petroleum. Some oil is found in the State of Falcon.

Rumania.—In Rumania three great folds composed of Tertiary deposits in the outer foothills of the Carpathian Mountains have yielded oil. The principal production is from the Department of Prahova a few miles north of Ploesti, which in turn, is north of Bucharest. Numerous salt domes and short anticlines in Transylvania have yielded considerable natural gas.

Iran.—The faulted and folded Tertiary sediments and salt deposits of the Shustar region of the lowlands and foothills of southwestern Iran have been quite productive from only a few wells. The chief field is the Masjid-i-Sulaiman, which includes the Maidan-i-Naftun and neighboring pools. A pipe line 140 miles in length carries the oil to Basra at the head of the Persian Gulf. Recently, at the demand of the Shah of Iran, the agreement of the Anglo-Iranian oil concession was revised.

Netherland India.—Sumatra is the largest producer of petroleum in Netherland India following the recent decline in the production in Borneo; Java ranks third in production, and the production from Ceram is very small. The oil deposits of Sumatra occur at the north end of the island in folded Tertiary sediments. Oil is produced from the folded sediments on the east coast of Dutch Borneo. Barren, metamorphic, igneous and Paleozoic rocks occupy the center of the island. Japan has recently been seeking a petroleum concession in Borneo. Oil is produced in eastern Java from domes and anticlines of Tertiary sediments. The small output of Ceram is derived from Tertiary sediments.

Mexico.—Three districts in Mexico produce oil; in the order of their importance they are as follows: Tuxpam (the southern district), Tampico (the northern district), and the Isthmus district of Tehuantepec. The chief fields are in a district 150 miles long and 30 miles wide in the States of Vera Cruz and Tamaulipas. Oil seeps are numerous. Many of the wells have been great gushers and are extremely productive. The productive formations are of Cretaceous age, except in the Isthmus field, where the oil is found in Tertiary formations. The oils in general are heavy, with an asphalt base, and low grade.

Colombia.—Oil and gas are produced in Colombia from the Tertiary and Cretaceous deposits in broad valleys between the mountain chains and from disturbed Tertiary deposits of the Caribbean coast. The most important of these intermontane basins is the Magdalena trough. One organization, the Tropical Oil Co., produces all the oil output of Colombia. Recently the Barco Concession has become the scene of renewed activity.

Argentina.—Four separate regions produce petroleum in Argentina: (1) the eastern Andean front in the provinces of Salta and Jujuy; (2) the eastern Andean front in the Province of Mendoza; (3) a district along the Andean front south of the Province of Mendoza and Neuquen Territory; and (4) the Patagonian Coast of Chubut Territory. The Comodoro Rivadavia field, the largest in Argentina, is located in Chubut Territory in an area of faulted and domed Cretaceous beds. The field is located relatively near the sea, and the oil is shipped to northern Argentina by tanker. A large part of the oil resources of Argentina has been nationalized.

Peru.—The faulted and flexed Tertiary beds in northwestern Peru have long yielded petroleum, the Tumbes-Paita field being the principal producer. The Andean mountainland has been too highly disturbed and affected by volcanic activity to yield petroleum in any abundance.

Trinidad.—Most of the petroleum from the Island of Trinidad has come from folded and faulted Cretaceous and Tertiary beds of the southwestern lowlands. The presence of petroleum and natural gas is shown by the numerous oil and gas seeps, veins of bitumen (manjak), and asphalt deposits, of which the largest is the well-known Pitch Lake.

British India.—The largest petroleum deposits of British India are those of the Irrawaddy basin of Burma. Several fields produce oil from shallow wells dug by hand. All of the petroliferous formations are of Tertiary age. Petroleum is also produced along the northern margin of the Indus-Ganges basin in Punjab, in Assam in the Brahmaputra and Barak basins and on the Arakan Islands off the coast of Burma.

British Borneo.—The folded Tertiary deposits of Klias Peninsula, Brunei Peninsula, and Lubuan Island off Brunei (British Borneo) show many surface manifestations of petroleum, as well as being quite productive. It will be recalled that on the eastern side of the island, in Netherland Borneo, petroleum is produced in considerable amounts. At Miri in Sarawak (British Borneo) petroleum is produced from folded Tertiary sediments.

Poland.—The petroleum production of Poland has declined steadily for a number of years, owing to gradual exhaustion of the fields. The Government has recently reorganized its petro-

leum services to give maximum assistance in an effort to recover the former production level attained by the industry. The Tertiary oil-bearing deposits of Poland consist of alternating beds of porous sandstone and impervious shale in an arclike zone about 270 miles in length and 30 miles in width extending from Cracow virtually to the eastern border of Poland. Production is derived from the anticlines on the northern border of the Carpathian Mountains. Numerous fields occur, of which the Boryslaw-Tustanowice pool is the most important. Ozokerite is mined from fissures in the Tertiary deposits near Boryslaw.

Iraq.—Iraq is a comparatively recent addition to the important petroleum-producing countries. Folded Tertiary formations promise production of much oil. Until August 1934 the output was small; at this time two great pipelines to the Mediterranean Coast were completed, whereupon output was greatly expanded. Recently proposals have been made to complete the Baghdad Railway from the Turkish border southward into Iraq. This railway will provide supplies and a means of shipping out certain extremely heavy crude oils which cannot be pumped through the pipe line. Most of the petroleum is exported to France.

Japan.—In Japan proper petroleum is produced from two fields, particularly the Echigo and Akita districts of the west coast of the Island of Honshu. These two small areas have produced 98 per cent of the Japanese output. Oil is also found in the western part of the Island of Hokkaido. The productive formations are of Tertiary age and have been folded. A small production is obtained from the Tertiary deposits of western Taiwan (Formosa). The wells in Taiwan are small producers and short lived. The Japanese also obtain oil from the Tertiary formations of Sakhalin in concessions leased from the Soviet Government.

Germany.—Production of petroleum has been increasing in Germany owing to the very active prospecting and exploitation policies being pursued there. The chief producing area is the Hannover district, with its faulted Tertiary beds. Salt and potash deposits form the cores of certain domes and folds. A small production is obtained from the Tertiary deposits of Bavaria. The faulted Tertiary Rhine basin of western Baden has been productive. All of Germany has of late been carefully prospected, but little hope can be entertained of extending production to the uplifted and folded blocks of Paleozoic rocks of southern and western Germany.

Egypt.—The folded and faulted Tertiary deposits of the narrow Egyptian Red Sea coastal plain on the west shore of the Suez Gulf produce oil, which in general, requires dehydration before sale. A small production has been reported from the Cretaceous and Tertiary deposits of the Sinai Peninsula. The nearly horizontal Cretaceous and Tertiary deposits of the Libyan Desert on the west and the Arabian Desert on the east are not rich in bituminous material. The seepages of oil and asphalt along the Red Sea have long been known.

Ecuador.—In Ecuador oil has been won from the highly disturbed Tertiary beds in the vicinity of Ancon since 1920. Shallow pits excavated on the Santa Elena Peninsula west of Guayaquil in Tertiary deposits produce oil. The oil seeps are probably related to the effects of the intrusion of igneous rocks.

Canada.—In Canada, oil is found in southern Ontario in gently arched Devonian limestones. A small amount is produced from the Mississippian rocks of Nova Scotia. In the Alberta basin oil and natural gas occur in the Cretaceous forms. Turner Valley, with its intricate fault structure, is the principal field. Large deposits of asphaltic sands are found along the Athabaska River.

France.—Oil is produced in France chiefly from the Tertiary deposits of the Pechelbronn basin in Alsace by means of wells and from shafts and galleries. A small production is reported from Gabian in Hérault. Natural gas has been produced spasmodically in the foothills of the Jura Mountains in the Department of Ain. France, however, depends for supplies on overseas production of oil.

Italy.—A small production of oil has been obtained from the Provinces of Emilia and Abruzzi in the Apennines, Campania, and the Lombard plain of northern Italy. Italy is reported recently to be receiving oil from southern Albania.

Czechoslovakia.—Between the Carpathian Mountains and the Bohemian upland of Czechoslovakia is the low-lying Moravian corridor, a structural continuation of the Vienna basin of Austria. Oil is produced in this depression at Gbely (formerly Egbell) and at Hodonin (Goeding) from Tertiary sediments.

Bahrein Island.—Bahrein Island is a newcomer among petroleum producers; it is an elongated dome of Tertiary deposits. Production is increasing rapidly. The adjoining mainland of Arabia is also being explored for oil.

Bolivia.—Bolivia produces oil from the Camiri and Sanandita fields. Oil is also produced from Bermejo field on the Argentinian border from formations of Carboniferous age.

Other Countries.—A small production of petroleum is reported in Albania, Austria, Barbados, Cuba, England, French Morocco, New Zealand, and Yugoslavia.

INDUSTRIAL USES

The World War emphasized with unmistakable clarity the importance of petroleum products to the industrial nations. From the standpoint of economy, automobile transportation depends broadly upon gasoline derived from petroleum for its motive power. Some idea of the importance of petroleum may be realized from the fact that mineral oil is the source of the largest quantity of lubricants used throughout the world.

As oil enters into competition with coal in various uses in factories, in transportation, and for household heating, the consumption of petroleum depends in part upon the existing local competitive factors of such energy-producing minerals as natural gas, coal, and hydroelectric power. Fuel oil, one of the principal products in the distillation of gasoline, enters the market in direct competition with coal. Gasoline, however, competes directly and indirectly with coal in certain uses only. On the other hand, lubricating oil produced from petroleum finds little competition in consuming markets. By far the larger part of the motor fuels marketed is in the form of gasoline; its consumption may be gaged with relative accuracy by the number of automobiles in use. Among the largest consumers of fuel oil are marine engines, railroad locomotives, public-utility power plants, oil boilers in manufacturing plants, and diesel-type engines. At present, railroads consume the largest amount of fuel oil.

SUBSTITUTES

Petroleum, natural gas, and coal, are at price interchangeable for many uses. During the last few years, fuel oil has largely

replaced bunker coal throughout the world. The production of petroleum from coal by hydrogenation may in the future compete commercially with natural petroleum products.

Reference

EMMONS, W. H.: Geology of petroleum, New York, 1931, 736 pp.

WORLD PRODUCTION OF PETROLEUM IN THE PRINCIPAL COUNTRIES OF THE WORLD, 1932–1934
(In Thousands of Barrels)

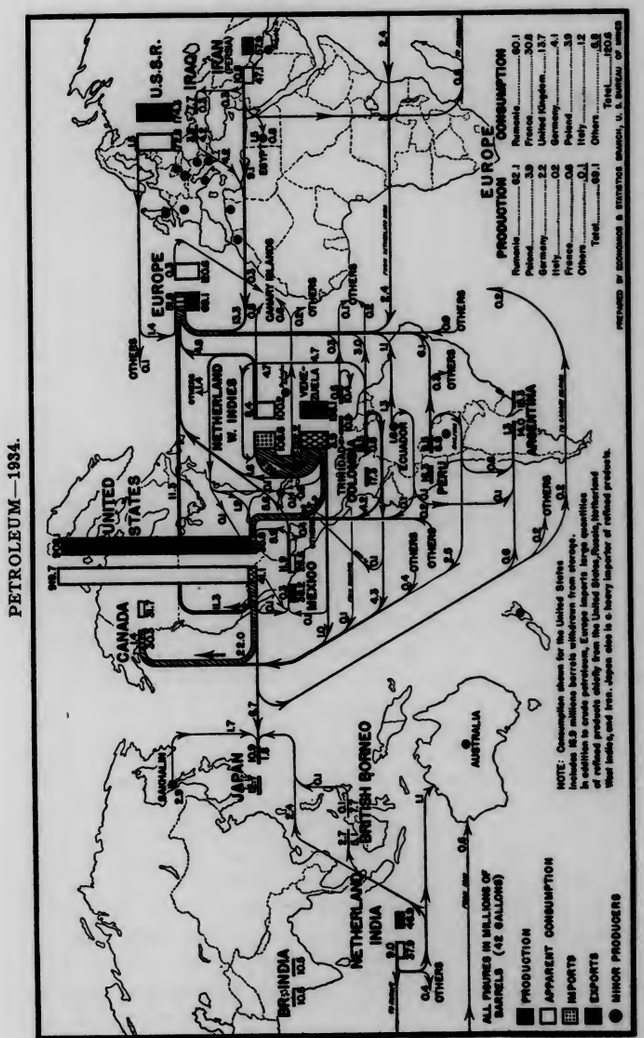
Country	1932	1933	1934
North America:			
Canada	1,044	1,145	1,417
Mexico	32,805	34,001	38,172
United States	785,159	905,656	908,065
South America:			
Argentina	13,139	13,691	14,024
Bolivia	44	112	159
Colombia	16,414	13,158	17,341
Ecuador	1,597	1,620	1,637
Peru	9,899	13,257	16,314
Trinidad	10,126	9,561	10,894
Venezuela	116,541	117,720	136,103
Europe:			
Czechoslovakia	126	122	178
France	530	562	557
Germany	1,608	1,665	2,187
Italy	208	204	151
Poland	4,116	4,072	3,913
Rumania	53,815	54,020	62,063
U.S.S.R. (Russia)[1]	155,737	156,166	175,950
Asia:			
Bahrein Island	.....	31	285
British Borneo	3,796	4,490	5,140
India, British	8,817	8,743	10,503
Iran	49,471	54,392	57,851
Iraq	836	917	7,689
Japan[2]	2,891	2,467	3,070
Netherland India	39,001	42,606	46,925
Africa:			
Egypt	1,895	1,663	1,546
Other countries[3]	62	71	96
Total	1,309,677	1,442,112	1,522,230

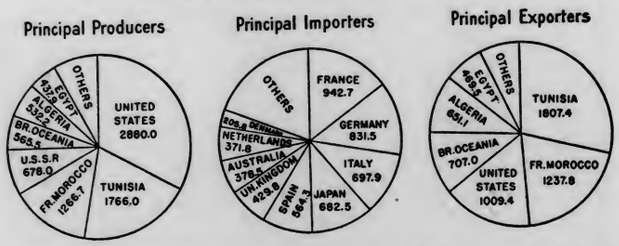
[1] Includes production in the European part of the U.S.S.R. in 1932, 151,870,000 barrels; 1933, 151,667,000 barrels; 1934, 171,445,000 barrels; Asiatic Russia, 1932, 2,497,000 barrels; 1933, 3,173,000 barrels; 1934, 2,873,000 barrels; and Russian Sakhalin, 1932, 1,370,000 barrels; 1933, 1,326,000 barrels; 1934, 1,632,000 barrels.

[2] Includes production in Japanese Sakhalin 1932, 1,261,000 barrels; 1933, 1,012,000 barrels; 1934, 1,249,000 barrels and that of Taiwan (Formosa) 1932, 32,903 barrels; 1933, 36,456 barrels; and 1934, 35,080 barrels.

[3] Other countries: Albania, Algeria, Austria, Barbados, Bulgaria, China, Costa Rica, Cuba, England, French Morocco, Greece, New Zealand, Palestine, Papua, Portuguese West Africa, Spain, Syria, Turkey and Victoria.

PETROLEUM—1934.





The mineral apatite, $(CaF)Ca_4(PO_4)_3$, is the principal primary source of the element phosphorus. This mineral occurs as a minor mineral constituent of most igneous rocks but only rarely as an intrusive mass, or, in other words, it seldom forms a body of sufficient size to be commercially minable. It is the accumulation of large quantities of animal excreta and remains that has formed the commercial phosphate rock deposits.

Most phosphate deposits[1] consist of more or less earthy phosphorites, whose physical characteristics vary with the proportion of their content of phosphate of lime to that of the impurities. They contain one or more varieties of the phosphates of lime, which are intimately mingled with other substances, both organic and inorganic. The organic substances are distinct fragments of skeletons of animals or diffused pigments that impart a more or less definite color to the inorganic materials. Phosphate rock occurs as a hard rock in beds that lie between strata of sandstone, shale, or other sedimentary rock, also as amorphous nodular pebbles in stream deposits, and as a residuum derived from the decomposition of phosphatic dolomite, limestone, and other rocks containing phosphate. Another type of deposit that is commonly classed as a phosphate rock is the porous coral or

[1] Stutzer, O., Die wichtigsten Lagerstätten der Nicht-Erze Phosphat Berlin, 1932, 293 pp.

limestone that is permeated with phosphate leached from guano.

The most common impurities are the oxides of iron and aluminum. Limonite is the prevailing iron-bearing mineral. Silica is a common constituent. Magnesite is sometimes present in the deposits.

The phosphate rock of Florida and South Carolina occurs as irregular deposits of pebbles and small lenses or boulders mixed with sand, clay, and soft phosphate. It is mined by dredges or steam shovels and by hydraulicking. In hydraulic mining the rock is disintegrated and washed by a powerful stream of water into a sump, from which it is raised by a suction pump to be washed and dried. In the western United States and in northern Africa the phosphates are produced by underground methods of mining. The ore as it comes from the mine requires no further treatment before shipment.

Occurrences of phosphate are widely distributed and, as a rule, of considerable magnitude. Because of the bulkiness and low unit value of the material, the deposits to have commercial value must be located relatively near cheap transportation, as well as the consuming markets. Depleted soils and increasing lack of animal manures in modern mechanized agriculture account for the growing demand for phosphate products.

The value of a phosphate deposit is based upon its tenor as to phosphorus. To be commercially profitable the material must contain 40 to 55 per cent tribasic phosphate, which in terms of P_2O_5 is 20 to 23 per cent.

PRINCIPAL DEPOSITS

United States.—The phosphate industry has been developed in the southeastern states. Sulphuric acid used in the production of super-phosphates is readily and cheaply obtainable from the cupriferous pyrite deposits of Tennessee and the enormous sulphur deposits of Louisiana and Texas. The Tennessee phosphate rock deposits are advantageously located to supply the older agricultural regions of the Middle West; the Florida phosphates are near the sea and can be transported cheaply, hence, what is not sold in the domestic market can be exported.

The Florida phosphatic sediments are of Tertiary age and extend in a belt some 200 miles long and 20 miles wide along the

west side of the state. Six classes of phosphates are recognized: hard rock, plate rock, land pebble, river pebble, soft phosphate, and phosphatic marl. The phosphate content ranges from 68 to 75 per cent.

Phosphates are found in the western part of the central Tennessee basin. The brown deposits, which are the most important, are formed as a residual product of the weathering and solution of Ordovician limestones. The beds are 6 to 10 ft. thick. The tricalcium phosphate content varies but may range upward to 72 per cent. The blue phosphate deposits, unlike the brown deposits, are of Devonian and Mississippian age; they are unaltered, comparatively thin, and range up to 4 ft. in thickness. As a rule they are high grade, containing up to 70 to 72 per cent tricalcium phosphate. The white phosphate, a residual product formed by decomposition of the brown and blue phosphates, is no longer mined.

Phosphate rock occurs in Idaho, Montana, Utah, and Wyoming. The deposits of these states are of Mississippian or Permian age.

Algeria, Morocco, and Tunisia.—The phosphate deposits of Algeria, Morocco, and Tunisia occur in thick, widespread Tertiary sediments and are of organic origin.[2] The phosphate industry has developed in North Africa owing to the demand of the great consuming centers of Europe, where more fertilizer is used per acre than in the United States. The producing deposits of phosphate in these countries are generally near the sea and are aided by a very fortunate trading and shipping arrangement, whereby the industrial products and coal of Europe are exchanged for the phosphate; this contributes not a little to the profits of the industry. The high quality of the deposits makes difficult any competition from Continental producers. Certain old producing centers of leaner phosphates, such as those of England, have been unable to withstand the competition of the North African product.

The hard, granular phosphate of Algeria and Tunisia is of organic origin and increases in phosphate content from the south toward the north and east. The minimum average tricalcium

[2] Bureau d'Études Géologiques et Minières Coloniales, Les ressources minérales de la France d'outre-mer. IV, Le phosphate. Paris, 1935, 207 pp.

phosphate content is 58 per cent. The thickness of the deposits ranges between 1 and 3.5 m.

The Moroccan phosphatic beds cover an area of 150 sq. km. in which the horizons average 1.7 m. in thickness, making a volume of about 250,000,000 cu. m. of phosphate. The deposits are soft and easily mined. The purified product contains about 75 per cent tricalcium phosphate. Transportation will aid in bringing the phosphate from new deposits to the market. The high-grade Moroccan product can be produced more cheaply than those of Algeria and Tunisia. The phosphates of Algeria and Tunisia are shipped to France, while the Moroccan phosphates are shipped to other countries. A marketing agreement has been entered into between the African and American producers.

U.S.S.R. (Russia).—The most important deposits in the Union of Soviet Socialist Republics are in the Kola Peninsula, where phosphorus occurs in the form of apatite. In addition, extensive low- and moderate-grade phosphate rock deposits are found in central Russia. Improved and enlarged shipping facilities at Murmansk are making the Russian apatite concentrates more and more a competitor of North African phosphates in European markets. The deposits are handicapped by being situated long distances from the central and southern agricultural regions of the U.S.S.R.

Although the phosphate rock reserves of the U.S.S.R. are said to be large, in reality few high-grade commercial deposits are known. The large tonnages shown in reserve estimates are really too low in phosphate to figure in world trade.

Nauru and Ocean Islands.—Nauru and Ocean Islands, situated in the South Seas or Oceanica east of New Guinea and north of Australia in the Gilbert Archipelago, are important producers of phosphate. The phosphate beds were discovered about 1900. The deposits are about 15 m. in thickness. The upper part is composed of a black soil carrying 88 to 90 per cent tricalcium phosphate and passes downward into the underlying coral rock. The average content is about 85 to 88 per cent tricalcium phosphate.

Egypt.—The most important phosphate-rock occurrences of Egypt are in the Safaga region near the Gulf of Suez. The phosphates are shipped to India, Japan, and South Africa.

Christmas Island.—Christmas Island is situated in the Indian Ocean about 200 miles south of Java and is administered by the Government of the Straits Settlements. On this island are found deposits of phosphate in the form of phosphatized limestone about 60 cm. thick and carrying approximately 80 per cent tricalcium phosphate. The area first became productive in 1900.

Netherland West Indies.—Phosphate deposits occur in the southeast end of the Island of Curaçao in the Netherland West Indies, forming a sharp but irregular boundary with the underlying coral limestone. The deposits, about 20 m. in thickness, are about 1,000 m. in length and 250 m. in width. The rock averages 84 per cent tricalcium phosphate.

Makatea Island.—Makatea Island near Tahiti in the Society Islands is 7½ km. long and 3 to 3½ kilometers wide. The phosphate produced there resembles coarse gravel and covers the surface of an area of about 4 sq. km. to a depth of 1½ to 2 m. The tricalcium phosphate content runs 80 to 85 per cent. The phosphates are shipped to Japan and New Zealand.

France.—Phosphate rock is produced in France, chiefly in the Somme Department, from deposits of Cretaceous age. The phosphate content ranges between 20 and 40 per cent tricalcium phosphate.

Angaur Island.—This island was formerly one of the great sources from which Germany obtained its phosphate. The deposit is on a low-lying island in the Pelew Group, east of the southern extremity of the Philippines, which has an area of approximately 8 sq. km. The deposits are similar to those of Nauru and Ocean Islands; they cover an area of about 1 sq. km. and average about 2 m. in thickness.

Japan.—Phosphate is obtained in Japan from Kita Daito Island in the Borodino Group, situated some 600 miles east of Taiwan (Formosa). Here volcanic ash has been phosphatized. The occurrences are high-grade, having a tenor of some 75 per cent tricalcium phosphate. On Rasa Island 87 miles south of Kita Daito Island, phosphate occurs under similar conditions. Japan lacks enough phosphate to meet domestic requirements, and the South Sea Islands, particularly Angaur Island, supply the deficiency.

Peru.—The fertility of the terraced soils of the ancient Inca rulers of Peru was maintained by the use of guano. Phosphatic material is gathered from a series of barren islands off the coast of Peru. Here the material has been leached and the phosphate deposited in the vicinity of the rookeries of marine birds. Exploitation of these deposits is now subject to Government control, and production quotas are fixed for each of the islands.

Summary.—Summarizing the occurrence of phosphate, one notes that France controls the greater part of world phosphate production, followed by the United States. Next in order comes the United Kingdom, which controls the deposits of Safaga, Egypt, and Christmas Island and of Nauru and Ocean Islands in Oceanica. The Egyptian deposits of Kosseir are under Italian control.

That new deposits will be discovered seems probable, and, as has been the case with other minerals, development of new producers may change the location of the principal producing centers.

The fourteenth International Geological Congress, held in Madrid in 1926, reviewed[3] the reserves of all the world deposits of phosphate which contained over 5 per cent P_2O_5. Such an estimate is both incomplete and misleading, because the ores in certain countries shown to have large reserves actually are lean, and the beds too thin to be mined. Reserves and possible production do not bear any direct relationship to one another.

INDUSTRIAL USES

By far the largest part of the phosphoric acid required by agriculture is derived from phosphate rocks. The bulk of the phosphates used industrially is treated with sulphuric acid, which produces acid phosphate or superphosphates for use as fertilizers. A small part of the world output is used for various industrial purposes, such as in the manufacture of baking powder, phosphate water softener, and ferrophosphates used in the making of steel, and for the production of metallic phosphorus. A use of phosphorus that becomes important in war times is in the production of smoke screens as well as phosphine gases. The use of mineral phosphates is of comparatively recent origin. Prior to the middle of the last century, phosphatic materials were obtained largely from bones.

[3] Congrès Internationale Géologique, Madrid, 1926, Les réserves mondiales en phosphates, 2 vols., Madrid, 1926.

By the Thomas process, which is applicable to the reduction of high-phosphorus iron ores, a minor amount of phosphates can be produced. The process yields a slag high in phosphorus. This material does not compete directly with mineral phosphates but it supplements them.

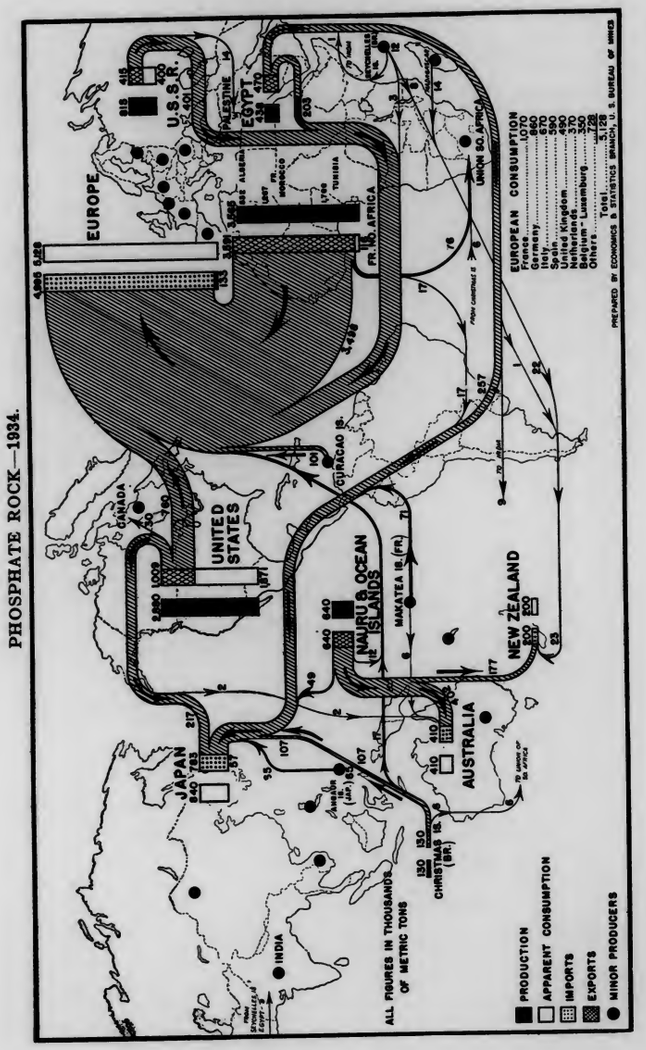
In Belgium, England, France, Germany, and Luxemburg, where iron ores high in phosphate are used, large quantities of basic slag are available. Germany, France, and the Netherlands are the principal producers. About 20,000 to 30,000 tons of basic slag are produced annually in the United States in the Birmingham (Ala.) district.

WORLD PRODUCTION OF PHOSPHATE ROCK, 1932–1934
(In Metric Tons)

Country	1932	1933	1934
Algeria	569,279	587,753	532,210
Angaur Island[1]	65,609	66,492	72,148
Australia:			
New South Wales	229	71	210
South Australia	654	26	
Belgium	25,810	25,130	14,385
Canada	1,194	2,008	73
China	8,000[2]	[3]	[3]
Christmas Island (Straits Settlements)[4]	85,548	92,745	129,780
Egypt	349,780	440,632	437,933
Estonia	1,133	8,950	10,609
France	82,700	71,124	79,252
Germany (Prussia)	[3]	[3]	735
India, British	123	38	60
Indo-China	373	.....	4,600
Japan	18,707	34,739	56,500
Madagascar	7,100	13,100	8,340
Makatea Island[4]	120,650	79,045	77,470
Morocco, French[5]	987,317	1,107,333	1,266,796
Nauru and Ocean Islands[6]	438,466	670,898	565,522
Netherland India	2,724	7,946	5,013
Netherland West Indies: Curaçao[4]	65,407	85,550	100,627
New Caledonia	1,000	6,000	2,000
Philippine Islands	830	3,097	[3]
Poland	[3]	6,350	[3]
Seychelles Islands[4]	14,213	12,307	12,062
Spain	9,980	14,507	19,297
Tunisia	1,678,000	1,810,000	1,766,000
Union of South Africa	1,183	1,181	77
U.S.S.R. (Russia)	387,000	687,000	[3]
United States (sold or used by producers)	1,734,300	2,530,282	2,880,017

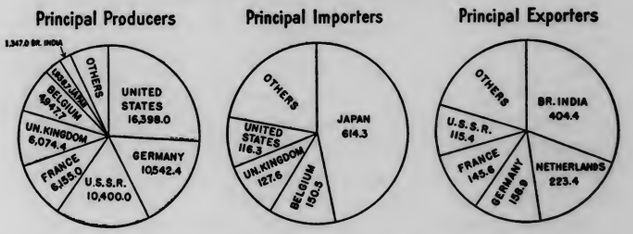
[1] Exports during fiscal year ended Mar. 31 of year following that stated.
[2] Estimated (Imperial Institute, London).
[3] Data not available.
[4] Exports.
[5] Shipments including exports as follows: 1932, 972,692 tons; 1933, 1,091,174 tons; 1934, 1,255,847 tons.
[6] Exports during fiscal year ended June 30, of year stated.

PHOSPHATE ROCK—1934.



PIG IRON AND FERRO-ALLOYS — 1934

(all figures in thousands of metric tons)



When iron ore is mixed with coke and flux and smelted in a blast furnace the resulting product is known as pig iron because it is cast into semicylindrical bars (pigs). These are about 5 in. wide and 36 in. long and weigh about 100 lb. Pig iron is remelted in a cupola furnace to make iron castings and is also made into wrought iron by the puddling process. The various kinds of steel are made by the Bessemer or the open-hearth process, using pig iron as the raw material. Pig iron is composed of about 93 per cent iron, 3 to 5 per cent carbon, and varying percentages of sulphur, phosphorus, silicon, and manganese.

Pig iron is classified according to its composition or fracture, its intended use, and its method of manufacture.

The various types of ores used in the manufacture of this commodity, in the order of their importance, are hematite, magnetite, limonite, siderite, and pyrite. Charcoal is employed as fuel in the production of the finest grades of iron but owing to the limited quantity available and its consequent cost, its use is limited. Anthracite can be employed but is not generally favored for operating reasons. The greatest quantity of pig iron is smelted with coke made from coal. Limestone and dolomite are used as fluxes. A blast furnace of United States construction will produce more than 600 tons of iron a day and during each 24-hr. period consumes some 1,100 tons of ore, 600 tons of coke,

and 300 tons of limestone, in addition to a large amount of water. Consequently it is evident that large tonnages of materials must be handled. Few districts have the ore, fuel, and flux in one locality, and countries that are so fortunate as to have them possess a great economic advantage over those which do not have such a favorable combination of materials. The economics of the industry has shown that it is more profitable to bring the ore to the fuel district than to transport the necessary coal to the ore district.

For many years the collection and re-use of scrap iron received slight attention from the producers of pig iron. However, the World War with its urgent demands for pig iron and its production of quantities of scrap materials led to the increased consumption of scrap. The quantities of scrap available can be appreciated when one considers the growing junk piles formed by abandoned automobiles, trucks, and other metal equipment. The development of iron and steel industries as an element of the national self-sustaining policy in countries having only small resources of iron ore led to the rapidly growing use of scrap iron. Less coke and flux are required to smelt and produce 1 ton of pig iron from scrap iron than from iron ore; hence an economy of labor, plant, and handling of materials is made possible.

The manufacture of pig iron produces slag in quantities that vary with the tenor of the iron ore smelted. The slag is used partly in the manufacture of mineral wool and phosphate fertilizers, the gases escaping from the top of the blast furnace being used as fuel. This practice is now general in Europe.

The location of a plant may be said to be that point where it can secure the most favorable balance of (1) selling prices, (2) service and quick delivery to the buyer, and (3) minimum costs of materials and labor. This means the possession of a high-grade supply of ore and of coking coal. Labor must be available for the manufacture of iron as well as steel. To operate at a profit a modern steel plant should be located near a center of population.

PRINCIPAL DEPOSITS

United States.—Pennsylvania is the largest pig-iron-producing State in the United States, while the greater Pittsburgh area is, in turn, the largest steel-producing district. This area was

selected because of its proximity to coal-producing regions and its location at the confluence of the Allegheny and Monongahela Rivers to form the Ohio River.

The Pittsburgh district has continued to thrive, but new units of the industry have been installed along the Lake ports of northern Ohio. The dual use of the cars (iron ore to the Pittsburgh mills and coal or coke as return freight to the Lake region) reduces the rates. The Lake ports have only to pay the cost of the lake transportation of the ore. The development of the automotive industry in Detroit provided a ready and growing market for the iron and steel.

The second great shift in production occurred with the creation of a steel center at Gary, Ind. This plant still depends on the Appalachian area for its coking coal. The plant was located here because of the great market being developed around Chicago and the upper Mississippi Valley.

An iron and steel industry has recently been established in St. Louis. A plant has been placed in operation at Duluth, Minn. to obviate high taxes on ore shipped from the state.

On the Atlantic seaboard another shift is taking place from Bethlehem, Pa., a region of coal and limestone using Lake Superior iron ore, to Baltimore Md., where supplies of ore are brought by ship from company mines in Cuba and Chile. Baltimore is a central location for catering to the great markets of the southern and northern Atlantic seaboard as well as being in a position to supply an expanding export market.

Birmingham, Ala., is another iron and steel district exceptionally well located near iron, coal, and limestone. The ores are of lower grade than the Lake Superior ores; they are also harder and must be mined by drilling and blasting, and afterward crushed. The ore contains more phosphorus than other ores of this country, and the cheaper Bessemer process cannot produce the best steel. Use of the open-hearth furnace here is limited because of the lack of scrap. The pig iron is first Bessemerized and then treated in the open-hearth furnace. Although this district may be one of the best iron districts in the world, it is steel rather than iron that the modern world uses.

U.S.S.R. (Russia).—The production of pig iron in the Union of Soviet Socialist Republics has in the past few years increased decidedly over the low production level to which the industry

had fallen after the World War.[1] The largest pig-iron-manufacturing centers are in the south along the Don River and in the Ural region. Other plants in Russia are situated near Moscow and near Leningrad; there are two plants in Siberia, one at Kuznetsk and the other at Petrovsk on Lake Baikal. Large sums of money have been expended in building new plants at Magnitogorsk, Kuznetsk, Azov, Zaporozhe, and Mariupol. Broadly speaking, Russia has been the only country during the past few years that has materially expanded its steel industry. The major commercial difficulty to be surmounted is the immense distances that not only the finished product but the basic raw materials, such as ore, coal, and flux, must be transported to centers of distribution and manufacture.

Germany.—Germany is one of the largest producers of pig iron in Europe. Before the World War the production was much larger than it is now, because Germany could use the ores and plants of areas that are now possessions of France, Poland, and Czechoslovakia. A very complicated industrial relationship had been built up between the companies exploiting the ore deposits of Lorraine and the Ruhr coking-coal deposits. After the loss of the ore deposits following the war the Ruhr coal industry was reorganized along still more efficient lines, as were also the iron and steel plants of the remainder of the Rhineland and Westphalia.

Iron-ore resources and their benefication are matters of intense interest in Germany. To manufacture modern steel it is necessary to import high-grade iron ores from such countries as Sweden, Norway, Spain, and Northern Africa. With the loss by the Versailles Treaty of the metallurgical coke obtained from the coals of Upper Silesia, part of the iron industry was removed to the Oder River, where scrap metal and Swedish iron ores were utilized, largely on account of the economy in the use of coke made possible by the utilization of high-grade iron ores and scrap. The capacity for the production of steel in Germany is barely sufficient to take care of domestic demands.

France.—As a result of the World War, France has become the most important producer of pig iron on the Continent and the owner of the largest ore reserves. France still depends upon

[1] STAHL UND EISEN, Die Eisenhüttenindustrie in Sowetrussland 1933 und Anfang 1934, vol. 54, No. 45, Nov. 8, 1934, pp. 1160–1163.

imports of coking coal to maintain its steel industry. The steel plants of France may be said to be modern in every way, in that they have been built since the World War and are broadly replacements of old plants destroyed during the hostilities. By far the largest part of the steel industry is located in northeastern France near the source of iron ore.

United Kingdom.—For many years Great Britain had the advantage over other pig-iron-producing countries, owing to the geographic situation of the iron ore, coal, and lime resources. With exhaustion of the high-grade iron ores, Great Britain became dependent upon imports, which are largely obtained from Sweden and Spain. Since 1920 the trend in Great Britain has been not only toward integrated plants combining the features of the smelter to the rolling mill in one great operation, but also toward location of such plants near the sources of the low-grade ores high in phosphorus. By far the largest tonnage of pig iron manufactured in England is produced by the acid or Bessemer process.

Belgium.—This country depends upon France and Luxemburg for a large part of its iron ore. Some of its coking coal must be imported from Germany. During the War the Belgian industry was destroyed, but as in the case of France, reparations payments and foreign capital have rebuilt the industry and thus rendered it modern and highly efficient. The consumption within the country is not large, as it is in France, and the surplus over consumption is in the main exported to Great Britain. The limitations sought by the Continental Steel Cartel and the protective tariff policy of the United Kingdom were heavy blows to the Belgian industry.

Luxemburg.—The Grand Duchy of Luxemburg has been a part of the Belgian Customs Union since 1922. Luxemburg has no coking coal, hence all of it must be imported. Some iron ore is imported from France. Internal consumption is very small, and most of the iron and steel is exported.

Japan.—Japan Proper is deficient in iron-ore resources, and its steel industry at present depends upon obtaining its requirements of high-grade iron ore and metallurgical coke from abroad. Early in the industrial development of Japan it became evident to those guiding its destiny that if Japan were to develop industrially it must become a manufacturer of iron and steel products.

In 1895 a group of young men was sent by the Japanese Government to the United States to study methods of manufacture of iron and steel. Four years were spent in this country, two years in Germany, and two years in England. On their return to Japan in 1904 the Imperial Steel Works of Japan was organized under government auspices, and since then the steel industry has been, broadly, a government operation.

For many years large quantities of scrap iron were imported from the United States and England, supplemented by such ores as could be obtained. Since the World War the largest part of Japan's requirements of high-grade iron ore has been obtained from British Burma.

The Imperial Steel Works of Japan is at Yahata in northern Kyushu, Japan proper. The location was carefully selected near tidewater in order that the raw materials necessary could be supplied by water transportation.

The iron and steel industry of Japan has expanded rapidly during late years.[2]

India.—The iron-ore resources of India are large enough to warrant the statement that they are adequate to meet demands for many years. With minor exceptions the only areas from which relatively large tonnages of ore are produced are in the native states of Bihar and Orissa. Iron-ore deposits occur in many states and provinces but are as yet unproductive. The Tata Iron & Steel Co. at Jamshedpur is the largest producer of iron ore in India, as well as the largest producer of finished steel products. Owing to local conditions, coal is transported to the ore, a reversal of the usual practice. The Bengal Iron Co. operates in Kulti in the Raniganj coal field, using ores from Singhbhum. The Indian Iron & Steel Co. is at Asansol near Kulti in the Asansol coal field. Kulti, Asansol, and Jamshedpur are all in the same general district. A small plant, known as the Rhadravati Iron Works, operates in Mysore. The World War gave an impetus to the development of the iron and steel industry. After the war, production diminished to such an extent that tariff protection was instituted and the industry is again on a commercial basis. Approximately 30 per cent of the output of

[2] REICHERT, J. W., Japans Eisen-und Stahlindustrie in ihrer wirtschaftlichen Entwicklung, *Stahl und Eisen*, vol. 54, No. 38, Sept. 20, 1934, pp. 979–986.

the iron and steel companies is exported, principally to Japan. Recent reports state that Japan is seeking an active interest in the Indian iron and steel industry.

The expansion of the iron and steel industry of India is retarded by the limited resources of coal capable of being manufactured into metallurgical coke.

Italy.—The iron-ore resources of Italy are confined largely to the Island of Elba and have only slight commercial importance. Italy is also deficient in its coal reserves and depends upon imports for its requirements. Scrap is used extensively as a raw material for the manufacture of iron and steel. A part of this supply has been obtained from the United States. To supply, in part, its deficiency in coal, hydroelectric power has been developed, and the electric furnace is in general use.

Czechoslovakia.—This country makes the largest output of pig iron of the minor producing countries. Coal, iron ore, and limestone are all available in the Prague region.

Manchuria.—Large deposits of sedimentary iron ore are found in the Province of Mukden. Since the World War there has been a small production of pig iron. A plant known as the Anshan operates about 200 miles north of Dairen and is owned by the Southern Manchurian Railway. In May 1933, a holding company known as the Showa Iron & Steel Co. was formed, and the steel industry was consolidated.

Union of South Africa.—Pretoria, Transvaal, is the site of a new iron and steel industry, which is operated by the Iron & Steel Corporation of South Africa. A premium will be paid on the local manufacture of crude iron and steel, and rapid growth of the industry is indicated.

Other Countries.—Smaller amounts of pig iron are produced in Australia, Austria, Brazil, Canada, China, Chosen, Finland, Hungary, Mexico, Netherlands, Norway, Poland, Rumania, Spain, Sweden, and Yugoslavia.

INDUSTRIAL USES

Pig iron is the product of one of the first stages in rendering usable in metallic form the iron contained in its ores. Where blast furnaces and steel mills are so located as to make it commercially feasible, the iron produced from the furnaces is run directly into car ladles and handled as "hot metal" or "direct

metal." In the United States more than 60 per cent of the iron is handled in this manner. It has been estimated, from a world standpoint, that more than 70 per cent of the iron used in the manufacture of steel and by foundries is in the form of pig iron. Pig iron for many years has been a commodity in international markets. Transportation by waterways has greatly widened its distribution.

The importance of pig iron to industrial nations may be gaged by the annual production. The largest part of the consumption is required in the manufacture of steel. It is also used directly in the form of wrought and cast irons and is the intermediate form from which all ferrous products are derived.

SUBSTITUTES

There are no known substitutes for pig iron.

References

BENHAM, F.: The iron and steel industry of Germany, France, Belgium, Luxembourg, and the Saar, *Lond. Camb. Econ. Serv., Spec. Mem.* 39, October 1934, 51 pp.

Die Eisenindustrie Deutschlands und der Welt *Der deutsche Volkswirt*, (Supplement to) vol. 10, No. 9, Nov. 29, 1935, 80 pp.

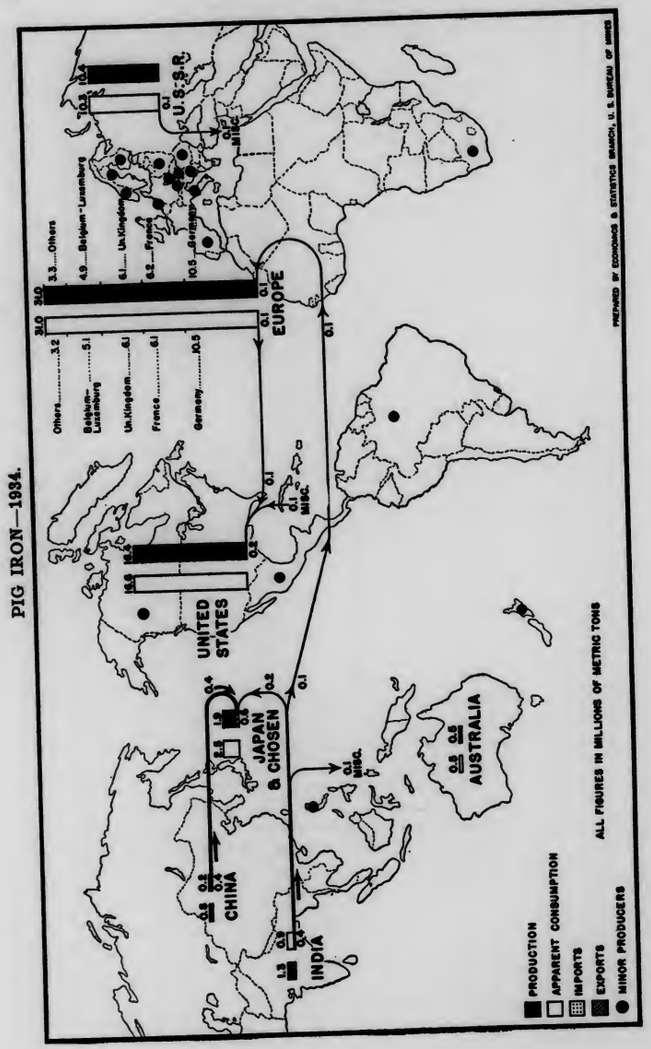
WORLD PRODUCTION OF PIG IRON AND FERROALLOYS, 1932–1934
(In Metric Tons)

Country[1]	1932	1933	1934
Australia[2]	400,000	425,000	450,000
Austria	94,466	87,949	133,492
Belgium	2,748,740	2,710,430	2,952,520
Brazil	28,809	46,772	56,924
Canada	162,179	261,582	441,916
China[2]	300,000	300,000	300,000
Chosen	163,653	163,937	175,502
Czechoslovakia	450,106	498,980	600,324
Finland	13,671	12,004	7,577
France	5,537,460	6,359,000	6,155,000
Germany (exclusive of the Saar)	3,932,364	5,265,000	8,716,739
Saar	1,349,493	1,591,200	1,825,670
Hungary	66,281	93,072	140,220
India, British	928,345	1,082,664	1,347,024
Italy	494,667	566,895	581,455
Japan	1,036,680	1,456,880	1,763,260
Luxemburg	1,958,930	1,887,538	1,995,193
Mexico	60,000[2]	53,500	54,000[2]
Netherlands	236,426	252,645	257,841
New Zealand	.....	3,339	1,358
Norway	103,092	112,653	126,932
Philippine Islands	168	100	150[2]
Poland	198,674	305,625	381,587
Rumania	8,752	2,013	61,635
Spain	300,617	338,853	372,366
Sweden	282,163	345,526	558,129
Union of South Africa	13,107	26,492	30,000[2]
U.S.S.R. (Russia)	6,173,000	7,133,000	10,400,000
United Kingdom	3,631,363	4,202,383	6,074,455
United States	8,920,878	13,590,926	16,398,077
Yugoslavia	9,973	30,756	32,620
Total	39,604,000	49,207,000	62,400,000

[1] In addition to countries listed, pig iron is produced in Chile, but figures of production are not available.

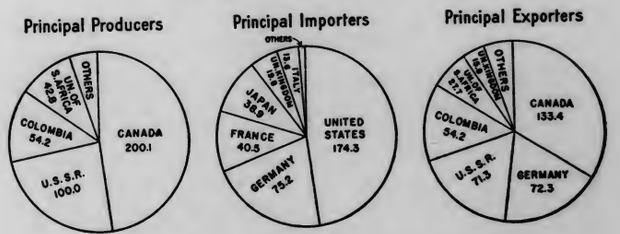
[2] Approximate production.

PIG IRON—1934.



PLATINUM — 1934

(all figures in thousands of troy ounces)



Platinum[1] is commonly found in nature as the metal, in combination with many minerals—frequently such metals as palladium, iridium, rhodium, ruthenium, and osmium, known as the platinum group—and associated with olivine-rich or ultrabasic rocks, such as dunite, but never with granites. Platinum occurs in the nickel-copper sulphides and is obtained as a by-product of the smelting operations. To a smaller degree it is also obtained as a by-product of the refining operations of certain copper ores. Platinum is commonly produced from alluvial and eluvial placer deposits and when so found consists of nuggets, scales, and sometimes irregular grains associated with chromite, ilmenite, and magnetite.

In the earlier days the more primitive operations made use of hand labor, sluice boxes, and hydraulic equipment where possible. Since 1896 the trend has been toward the increased use of dredges. Problems of concentration often must be solved by using special methods. Modern methods have been introduced into the refining process until today 90 per cent recovery of platinum is obtained from the sulphide ores.

Very little is known about the secondary recovery of platinum, but it is believed to be of considerable magnitude.

[1] Imperial Institute, Platinum and allied metals, London, 1936, 137 pp.

At the close of the World War an international syndicate was organized to control the platinum market. Prices rose but could not be sustained, as Russia refused to cooperate. The Consolidated Platinums, Ltd., was organized Oct. 21, 1931, to stabilize, prices and to secure international agreements controlling production. Although the company is still in existence it has not functioned since 1932.

PRINCIPAL DEPOSITS

Canada.—The most important platinum sources of Canada are the nickel-copper ores of Sudbury, Ontario, where platinum occurs associated with the sulphides. The great increase in platinum production is due to the discovery of rich ores in the lower part of the ore body of the Frood mine, as well as to the increased output of nickel. Platinum is obtained from the anode slimes produced in the process of electrolytic refining at Copper Cliff, Port Colborne, Ontario, and at Acton, London, England, by the International Nickel Co. and at Kristiansand, Norway, by the Falconbridge Nickel Co.

A small, irregular amount of platinum is obtained from the placer gravels of British Columbia.

U.S.S.R. (Russia).—Though production figures have not been published officially since 1927 it seems evident that the Union of Soviet Socialist Republics is still a substantial producer of platinum. This metal occurs chiefly in alluvial deposits in river beds or river terraces, and in the dunities in the vicinity of Nizhni Tagil in the Urals. Many of the areas have been worked several times and are still productive. Dredges have been introduced and now recover 80 to 90 per cent of the platinum. Losses still occur, as the tenacious clays tend to retain their platinum minerals.

Colombia.—The most important platinum deposits of Colombia are those of the Intendencia del Chocó. Platinum is also found in the Guapí and Barbacoas regions on the Pacific Coast and in alluvial deposits of the Cauca River in Antioquia Department. Many difficulties, such as lack of adequate transportation, unfavorable climate, unhygienic environment, and taxation, beset mining in this region. The platiniferous gravels of the terraces and streams are derived from areas of ultrabasic rocks. The

platinum is mined either by primitive or hand methods by one dredging company, the South American Gold & Platinum Co.

Union of South Africa.—New discoveries during the last decade have enabled the Union of South Africa to become one of the important producers of platinum metals. The Rand gold mines began with the recovery of platinum metals in 1923. In 1924 alluvial deposits were found in the Lydenburg district, eluvial deposits were found on the Onverwacht farm, and on the Merensky reef a platinum- and sulphide-bearing horizon was discovered in the Bushveld igneous complex. In 1925 important deposits of platinum were found in another zone of the Bushveld complex. The Onverwacht farm deposit in depth was found to be a pipe of dunite in which the platinum was erratically distributed. As mining progressed the platinum content decreased, and the deposit is now no longer mined. Except for rich stretches at Rustenburg the Merensky reef could not be mined because of the low tenor of the ore.

Of the large number of companies organized to work the deposits, only the Rustenburg Platinum Mines, Ltd., with plants at Kroondal and Klipfontein, is in operation. Despite mergers, this mine was closed in April 1932, but was reopened in July 1933. The unique vein deposits of the Waterburg district were worked during the period 1924–1926.

Ethiopia.—In 1926 A. Prasso, an Italian using French capital, began to exploit secondary deposits of southwestern Ethiopia along the Birbir River of Wallega Province.[2] A native firm, the Daressa & Workneh Co., also produced a small amount of platinum. Transportation difficulties confront mining operations in this region. Roads are now being built to the concession from the Anglo-Egyptian Sudan. Primitive mining methods and theft account for large losses of platinum. The concentrates are exported for refining.

United States.—The production of primary platinum in the United States is relatively small. Alluvial platinum is produced in the Goodnews Bay district, Alaska. Platinum is obtained by dredges as a by-product of alluvial gold mining in Merced, Stanislaus, and Sacramento Counties, Calif. The platinum seems to have been derived from the ultrabasic rocks in the gold belt.

[2] VON ZUR MÜHLEN, L., Die Platinlagerstätten am Birbir in Westabessinien, *Metall und Erz*, vol. 33, No. 13, July 1, 1936, pp. 349–353.

Similar geological conditions prevail in Josephine County, Ore. Platinum is won from the beach placer deposits of Curry and Coos Counties, Ore.

Belgium.—Platinum is recovered at Antwerp, Belgium, by the Société Générale Métallurgique d'Hoboken as a by-product of the refining of the copper ores of Katanga, Belgian Congo.

Other Countries.—A small amount of platinum is produced in Australia (New South Wales), Japan, Papua, and Sierra Leone.

INDUSTRIAL USES

The principal use of platinum is in the jewelry industry. Platinum-clad nickel has been produced for medals, watchcases, dresser sets, and similar commodities. However, it plays a very important part in the industrial world, where large quantities are used as a platinum-iridium alloy in the electrical industries, particularly by the telephone, telegraph, and electrical control systems.

Pure platinum has been in use for a number of years as a catalyzer and for the manufacture of sulphuric acid. It is also used for the same purpose in the manufacture of fixed nitrogen. During the last few years the consumption of platinum as a catalyzer has materially decreased because vanadium sponge may be used as a substitute. Platinum forms an important adjunct to the equipment of any chemical laboratory.

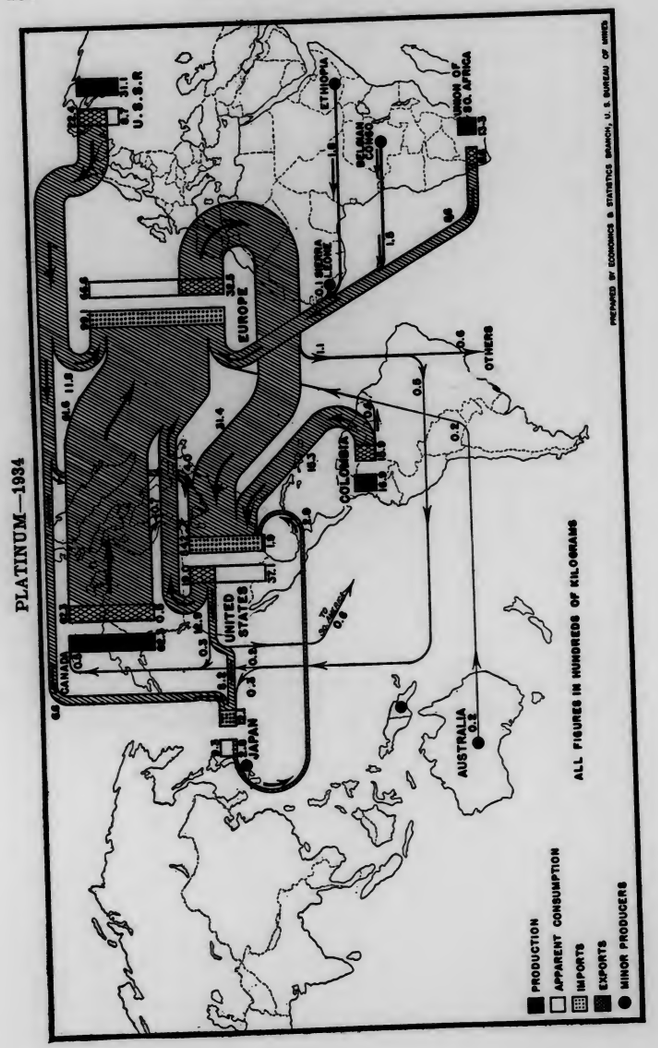
SUBSTITUTES

Broadly, with the exception of a small supply of platinum used in chemical laboratories, substitutes are known for all uses. The use of platinum is a convenience but not a necessity.

WORLD PRODUCTION OF PLATINUM AND ALLIED METALS, 1932–1934
(In Troy Ounces)

Country	1932	1933	1934
Australia:			
New South Wales: Placer platinum	336	113	180
Tasmania: Placer osmiridium	785	548	488
Belgian Congo: From refineries: Palladium	2,025	547	3,569
Platinum	96	.....	1,254
Canada: Placer platinum	59	40	53
From refineries:[1] Platinum	27,284	24,746	116,177
Other platinum metals	37,593	31,009	83,932
Colombia: Placer platinum (exports)	16,055	44,543	54,216
Ethiopia: Placer platinum	4,823	3,215	5,644
Japan: Placer platinum	267	207	118
Papua[2]: Placer platinum	2	.....	96
Placer osmiridium	1	29	4
Sierra Leone: Placer platinum	531	431	474
Union of South Africa: Platinum (content of platinum metals)[3]	7,766	.....	26,369
Concentrates (content of platinum metals)[3]	1,480	2,386	11,372
Osmiridium[4]	6,523	6,712	5,088
U.S.S.R. (Russia): Placer platinum[5]	100,000	100,000	100,000
United States: Placer platinum	1,074	1,266	3,720
From refineries[6]: Platinum	1,694	1,050	1,062
Other platinum metals	1,150	707	1,273

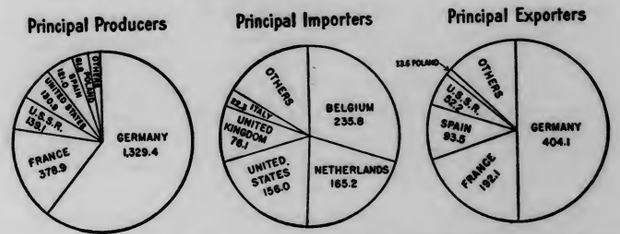
[1] Recovered from nickel-copper mattes.
[2] Year ended June 30 of year stated.
[3] Produced from platinum ore.
[4] Produced from treatment of gold ores on the Rand.
[5] Approximate production.
[6] New platinum recovered in gold and copper refining of domestic material.



POTASH — 1934

(Equivalent K_2O)

(all figures in thousands of metric tons)



The term *potash*[1] has come to include all potassium compounds, though the trade restricts the term to the hydroxide and carbonate of potassium and chemists to oxide of potassium. The principal water-soluble minerals forming potash are as follows: sylvite, a potassium chloride; carnallite, a hydrous double chloride of potassium and magnesium; kainite, a hydrous double salt (a compound sulphate of magnesium and chloride of magnesium); polyhalite, a translucent to opaque brick-red mineral (a hydrous sulphate of calcium, magnesium, and potassium); and langbeinite, the transparent to white or yellow double sulphate of magnesium and potassium. Other soluble potassium minerals are formed by the evaporation of ground waters at the surface, as in the nitrate deposits of Chile or in small sheltered places such as caves. Insoluble minerals which contain appreciable amounts of potassium are glauconite and the silicates—mica and nephelite.

Crude carnallite salts contain about 60 per cent carnallite and a potassium equivalent of 9 to 12 per cent potash. Kainite is said to contain on the average, 60 per cent kainite and 2 per cent sylvite, with a potassium equivalent of about 12 to 15 per cent potash. Crude hartsalz contains a potassium equivalent of 12 to 15 per cent pure potash. Sylvinite is an admixture of sylvite and rock salt. The term is also applied to various kinds

[1] JOHNSON, B. L., Potash, *U. S. Bur. Mines, Econ. Pap.* 16, 1933, 78 pp.

of salts with a high potassium content of 12 to 15 per cent pure potash. Hartsalz and sylvinite are salt mixtures in which sylvite dominates.

The salts are marketed as kainite, manure salts, muriate, and sulphate. Kainite is marketed without previous treatment. Refined sulphate of potash is made by refining the crude material and by treating potassium chloride with sulphuric acid. Manure salts, muriate, carnallite, hartsalz, and slyvinite are dissolved in hot water and allowed to cool; the potassium separates as potassium chloride in two grades. The part that contains 30 to 50 per cent potassium chloride is sold as manure salts, and the part containing more is sold as muriate after being partly refined and recrystallized.

In the German deposits, carnallite, kainite, and sylvite are the most important minerals. Sylvite is virtually the only potassium mineral in Alsace. Sylvite, kainite, and langbeinite are the chief minerals in the Polish deposits. Carnallite and sylvite are the most important potash minerals in Spain and Soviet Russia. In the Texas-New Mexico field polyhalite is the most abundant, with sylvite in some parts of the field.

Potash has been studied with a great deal of diligence because of its agricultural importance. Although potassium is widely distributed in nature, forming insoluble compounds with silica, it does not occur abundantly in the soluble form. Potassium salts have accumulated in the ocean but, with few exceptions, not in sufficient concentration to be commercially exploitable. Potash is concentrated by the natural process of fractional crystallization or continuous drying of land-locked bodies of water, to which new supplies of saline solutions are added from time to time. First gypsum is precipitated, then sodium chloride, and lastly the potash salts from the brines.

PRINCIPAL DEPOSITS

Germany.—Germany continues to hold her dominant position in the potash industry. The revival of agriculture and a carefully planned foreign trade have aided the industry in the face of the competition of new producers and the development of substitutes. The German Government has for a long time maintained rigid control of the industry within its borders. Beds of rock salt and potash salts occupy an enormous basin beneath

the plains of central Germany. In some places the beds are nearly horizontal, while in other localities they have been deformed into gentle arches and in still others into steep and complicated folds which may have been faulted. Besides this large central basin potash salts also occur in the Bromberg basin of eastern Prussia, in the Hesse-Thüringian basin of south central Germany, and in the much-faulted zone of the lower Rhine region near the Ruhr district.

France.—Potash salts are found in France near Mulhausen in upper Alsace. The deposits underlie an area of 70 sq. mi. and are 6 to 30 ft. thick. The beds are some 2,000 ft. below the surface. The salts consist of sylvinite. Very little carnallite or magnesium chloride is present. Salts containing considerable potash are reported from the Pyrenees region of southwestern France.

U.S.S.R. (Russia).—The most promising potash reserves of the Union of Soviet Socialist Republics are found in the Solikamsk-Bereznikov region 150 miles west of the central Ural Mountains. Here the deposits of sylvite are of Permian age and lie in a basin similar to that of central Germany. Exploratory and development work has been carried forward rapidly, and large reserves have been outlined. Rich potash brines fill certain lakes in Crimea and the Caspian region. A very considerable expansion of potash production is anticipated from the Soviet deposits, but increased consumption by domestic agriculture should use increasing amounts of this product.

United States.—After a long search and utilization of minor sources of potash compounds large deposits of potash salts were located in southeastern New Mexico and the adjoining regions of Texas. This potash is associated with sodium chloride in beds and occurs in an old marine basin of Permian age. After considerable technological research production has greatly increased. Improvement of agriculture in the United States has increased the demand for potash. Potash is produced in small quantities from the brines of Searles Lake in southern California as a by-product of borax and of magnesium chloride manufacture.

Spain.—Potash deposits occur as beds in a basin of Tertiary age situated in the Ebro basin between the Pyrenees and the Iberian Mountains of Spain, in the Province of Barcelona. The potash was discovered in 1912; production began in 1925, but

it was not until 1932 that a position of importance was attained. Production has continued to expand, aided by gains in export trade, especially to the important Dutch and American markets.

Poland.—Two districts in Poland contain potash deposits of Tertiary age. The western Polish district is the eastern extension of the Bydgoszcy district of eastern Germany. Very little potash is produced in this district. The eastern district centers about Holyn, Kalisz, and Stebnik in Galicia in southeastern Poland.

Palestine.—Evaporation of the waters of the Dead Sea accounts for the recent development and increase of potash production in Palestine.

Deposits of Other Potash Minerals.—Alunite is a hydrous sulphate of aluminum and potassium containing 11.4 per cent potash. It occurs in veins in certain altered lavas. The largest production of potash salts from alunite comes from Chosen, although a small amount of alunite is mined in the United States and Italy. Alunite deposits are known in Utah, Arizona, and California. A small production is reported from the Utah deposits.

Leucite is a potassium-aluminum silicate mineral bearing 21.5 per cent potash and is a constituent of certain eruptive rocks. Leucite-bearing lavas of Mount Vesuvius are utilized in the region of Naples, Italy, as a source of potash. Much research has been carried on with a view to producing potash from these deposits, but so far the operations have not been profitable. The Leucite Hills of Wyoming are likewise composed of leucite-bearing lavas. No production is recorded from this source.

INDUSTRIAL USES

Potash is an essential ingredient of commercial fertilizers. As a plant food it has no substitute. It occurs in one form or another in many places throughout the world, but there are only a few localities where there is sufficient concentration to make the occurrences of commercial value. World sources are therefore restricted.

Potash, nitrogen, and phosphoric acid are the essential materials that maintain plant life. As these elements rarely occur associated in soils, one or the other must be added to maintain the fertility of the land. Without the addition of potash, agricultural land would ultimately become barren.

For many years before the World War, Germany practically held a monopoly on potash salts.

It has been estimated that approximately 95 per cent of the potash used throughout the world is consumed for fertilizer purposes. Certain crops and certain types of soil demand it if productive agricultural fertility is to be maintained. One crop of cotton requires a large amount of potash. Other industrial uses are as caustic potash and in the manufacture of soap, high-grade glass, electric-light bulbs, and optical glass. Potassium chlorate is one of the chief ingredients in the manufacture of matches. Minor quantities of potash are used in making explosives, in the tanning and dyeing industries, and in metallurgy, where potassium cyanide has been used largely in the cyanide process as a solvent in extracting gold from finely ground ores. Photographic, medicinal, and miscellaneous chemical uses require but a small consumption of potash salts.

SUBSTITUTES

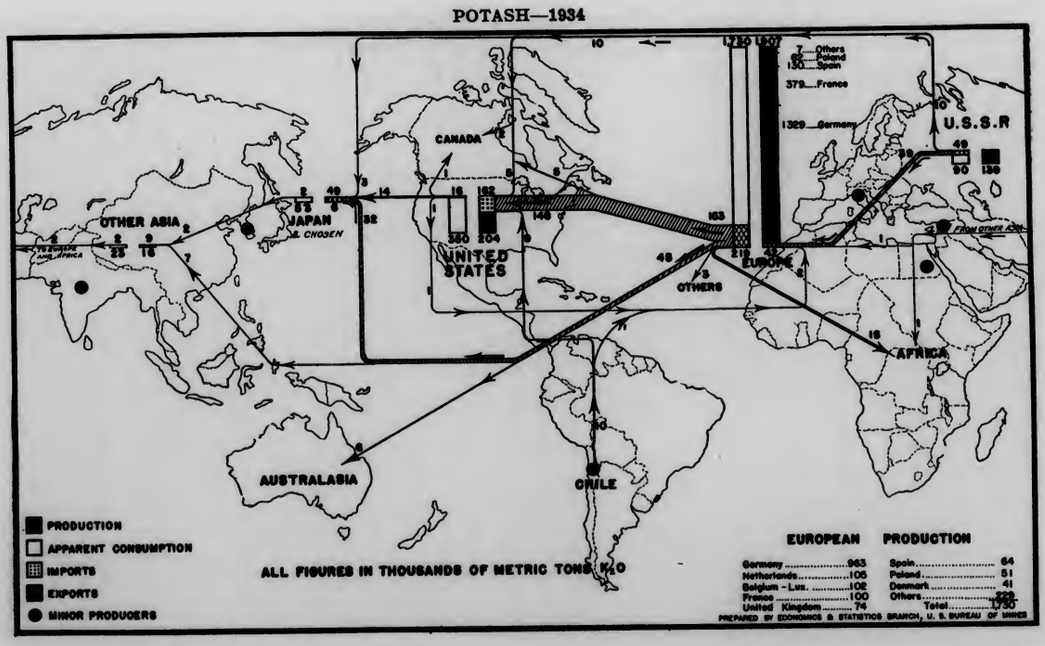
There are no known substitutes for potash.

WORLD PRODUCTION OF POTASH MINERALS AND EQUIVALENT K_2O, 1932–1934 (In Metric Tons)

Country and mineral[1]	1932		1933		1934	
	Gross weight	Equivalent K_2O	Gross weight	Equivalent K_2O	Gross weight	Equivalent K_2O
China: Potassium carbonate[2]	15	[3]	22	[3]	57	[3]
Chosen: Alunite	16,320	[3]	27,220	[3]	56,330	[3]
Egypt: Crude potassium salts	8	[3]	4	[3]	.....	.....
France: Crude potassium salts	1,920,000	326,500[4]	1,890,600	332,000[4]	2,054,400	378,900[4]
Germany: Crude potassium salts						
Carnallite (including natural kieserite)	635,940	61,245	642,445	65,285	829,669	81,020
Kainite, sylvinite, and hartsalz	5,779,591	810,109	6,720,326	960,829	8,787,010	1,248,408
India, British: Potassium nitrate[5]	9,100	4,400	10,000	4,900	9,100	4,400
Italy: Alunite	700	84	534	64	1,605	193
Leucite rock	44,000	3,520	.....	.....	.....	.....
Palestine: Crude potassium salts	10,200	5,100	15,000	7,500	[3]	8,982
Poland: Kainite	44,692	4,759	62,537	6,979	86,172	10,217
Langbeinite	.....	.....	.....	.....	1,470	300
Sylvite	231,966	52,285	236,608	70,391	213,906	51,337
Spain: Crude potassium salts	409,888	54,811	623,941	90,637	872,839	121,002
Potassic earth	750	[3]	500	[3]	500	[3]
U.S.S.R. (Russia): Crude potassium salts	[3]	[3]	303,094	42,122	1,001,602	139,197
United States: Crude potassium salts	129,836	56,236	302,191	130,070	250,139	130,944
Total		1,380,000[6]		1,710,000[6]		2,175,000[6]

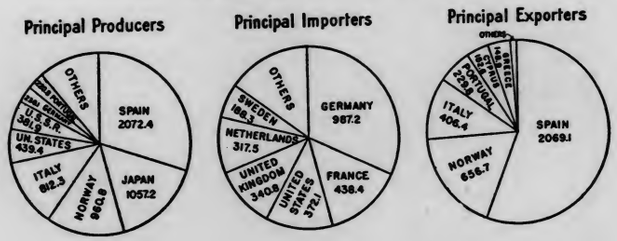
[1] In addition to the countries listed, Chile and Iran are reported to produce potash salts, but no statistics of output or export are available.
[2] Exports.
[3] Data not available.
[4] Content of marketable products.
[5] Estimated output (Imperial Institute, London).
[6] Approximate production.

POTASH—1934



PYRITES — 1934

(all figures in thousands of metric tons)



Pyrites[1,2] is the indefinite general trade name for any of the iron sulphide minerals containing 25 to over 50 per cent sulphur. The minerals composing this group are (1) Pyrite (FeS_2), a brassy-yellow mineral which may occur in well-crystallized forms or appear massive and show no crystals. Pyrite when pure contains 53.4 per cent sulphur and 46.6 per cent iron and may also contain small amounts of arsenic, nickel, cobalt, copper, gold, zinc, and tin. (2) Marcasite (FeS_2), which has the same chemical composition as pyrite and is difficult to distinguish from pyrite, particularly in the massive state. It is pale yellow to almost white, but the color deepens on exposure. Marcasite may be distinguished from pyrite by its color, crystal form, and the sulphur residue formed when the mineral is dissolved in nitric acid. (3) Pyrrhotite, a mineral of varying composition. Different formulas ranging from Fe_5S_6 to $Fe_{16}S_{17}$ have been given; however, $Fe_{11}S_{12}$ is that usually accepted. The sulphur content of pyrrhotite (38 to 39 per cent) is generally too low to be used as a source of sulphur unless such impurities as copper, nickel, or cobalt are present in considerable quantities. Pyrrhotite has

[1] Congrès Internationale Géologique, Madrid, 1926, Les réserves mondiales en pyrites, 2 vols., Madrid, 1927, 703 pp.

[2] Ridgway, R. H., Pyrites, general information, *U. S. Bur. Mines, Inf. Circ.* 6523, 1931, 26 pp.

a brownish bronze color with a metallic luster, but tarnishes easily. It generally occurs in massive form with a granular structure.

The trade name cupreous pyrites is applied to pyrite ores accompanied by considerable amounts of chalcopyrite ($CuFeS_2$), from which copper is extracted by leaching or by concentrating and smelting. Such ores are found in Spain and Norway.

Pyrite occurs in rocks of all ages from the most ancient to the most recent and in rocks of all kinds, whether igneous, sedimentary, or metamorphic. Nearly all the sulphide deposits mined for sulphur and copper are lenticular masses of great size and relatively deep-seated origin and are associated with igneous intrusives. The developed pyrite deposits occur thus at favorable localities in the deep parts of old mountain chains which have now been brought close to the surface by continued erosion. The general association of pyrite deposits with mountainous regions is world-wide. The Appalachian and Rocky Mountains, the Urals, and the mountains of Norway may be cited as examples. Some pyrite deposits appear to be distinct veins and others to be formed through impregnation or replacement of the country rock as great irregular masses or lenses by solutions from a deep-seated source.

Marcasite is a much less abundant mineral than pyrite but may occur with it. It is a relatively unstable mineral generally found close to the surface. It occurs in mineral veins as crystals, as nodules in chalk marl, and in coal and clay.

Pyrrhotite is a high-temperature mineral and is not known to occur in ores of low or intermediate depths. It is found in small quantities scattered through igneous and metamorphic rocks and in mineral veins or lodes.

PRINCIPAL DEPOSITS

Spain.—The Rio Tinto deposits of pyrite, the largest in the world, are in Huelva Province, Spain. The pyrite occurs here as some 50 lenses with dimensions ranging from 1,200 to 6,500 ft. in length, 750 ft. in width, and 500 to 1,800 ft. in depth. These deposits are distributed over a belt 100 miles long and about 15 miles wide. The ore is a mixture of chalcopyrite, pyrite, and other sulphides from which copper, lead, silver, and gold are

won. The ore contains 42 to 48 per cent sulphur and 0.5 to 3.0 per cent copper.[3]

Norway.—Norway has the second largest pyrite deposits in Europe. These pyrite and associated copper ores form the principal part of Norwegian mining production. The sulphur content ranges between 39.5 and 49.5 per cent, with an average of 44 per cent. The ores occur along the central mountain system and were formed as a result of the igneous intrusions that accompanied the folding of this mountain system. The deposits occupy three zones in southern Norway. Three genetic types may be identified: (1) pyrites formed following eruptions of lavas; (2) pyrites occurring as segregated deposits crystallized from once-molten deep-seated igneous rocks (the largest and most numerous deposits are of this type); and (3) pyrites crystallized from solutions emanating from melts of a granitic composition. The geology of the deposits within each group is quite similar.

Japan.—Three types of pyrite deposits are found in Japan: (1) bedded deposits in crystalline schists and slates; (2) massive deposits in volcanic lavas and ash and in their contacts with adjacent ash beds or shales; and (3) fissure veins in volcanic lavas and their ash beds. The bedded deposits are the chief sources of ore supply. These deposits are situated on the Island of Honshu.

Italy.—The pyrite ore bodies of Italy consist of irregular masses or horizons and veins in schists or at the contact of the schists or limestones. About seven-eighths of the Italian pyrite comes from the mines at Gavorrano in the Province of Grosseto, Tuscany, where the pyrite occurs at the contact of Triassic limestones and granite. The ore bodies have an irregular form, a length of 150 m., and a maximum width of 50 m.; they extend to an undetermined depth. Other small pyrite deposits are situated in the Firenze district, Tuscany; the Torino district, Piedmont; the Padova district, Veneto; the Carrara district, Liguria; and the Trento district of Trentino.

United States.—Production of pyrite in the United States comes chiefly from Tennessee, Virginia, and California. Other producing states are Colorado, Illinois, Kansas, Missouri, Montana, New York, and Wisconsin.

[3] WILLIAMS, D., The geology of the Rio Tinto mines, Spain *Inst. Mining Met., Bull.* 355, April 1934, 48 pp.

Portugal.—The pyrite zone of Alemtejo Province in Portugal is the western continuation of the pyrite zone of Huelva Province of Spain. The San Domingos mine at Beja is the principal source of pyrite.

Cyprus.—A large deposit of pyrite is found near the coast in the Nicosia district, Cyprus. The ore contains 47.5 per cent sulphur, 2.5 per cent copper, 41.8 per cent iron, and 0.01 per cent arsenic.

Germany.—The pyrite deposits of Germany are those of Rammelsberg, Goslar, and Meggen in Westphalia. The Rammelsberg deposits consist of a folded, bedded vein in slates. The ores have been altered after their emplacement. At Meggen an oolitic pyrite forms an extensive horizon 12 to 20 ft. thick in folded sediments. Barite and sphalerite also occur. These deposits are believed to be of sedimentary origin.

France.—The pyrite deposits of France are at Saint Bel near Arbresle, Rhone Department, and also near Calmoux, Saône-et-Loire Department. The former deposits, which produce almost all the French pyrite, consist of two parallel groups of masses of pyrite in metamorphic rocks. The average sulphur content is 48 per cent, and the arsenic content low. The Calmoux pyrite lenses are in sedimentary rocks intruded by granite dikes.

Greece.—Two districts produce pyrite in Greece: (1) the Cassandra Peninsula, a minor peninsula of the Chalcidice Peninsula of Macedonia, and the Chalcidice Peninsula itself; and (2) the Hermione or Kastri district at the end of the Argolis Peninsula in the Peloponnesus.

Sweden.—The cupriferous pyrite deposits of Sweden are grouped about three well-defined areas: (1) the central and most important area, that of the well-known and long-exploited copper mines of Falun; (2) the Skellefte area some 200 km. in length, situated along the Gulf of Bothnia (the pyrite lenses of this district also contain arsenic and zinc); and (3) the northwest area, extending along the Norwegian border in the Provinces of Västerbotten and Jämtland. The pyrites are rich in copper, zinc, and magnetite.

Canada.—Pyrite deposits in Canada are widely distributed in the better-known southern and western portions. The mining of pyrite is with few exceptions a major by-product of the mining of copper, gold, lead, nickel, and zinc. Large deposits of pyrite

occur at Hidden Creek, Kimberley, and Copper Mountain, British Columbia; and at Flin Flon, Manitoba. Pyrite is found in the region north of Lake Superior, in southeastern Ontario, and in the vicinity of Hastings. In Quebec pyrite occurs in the Noranda district and in the Eastern Townships, particularly at the Eustis copper mine near Ascot.

U.S.S.R. (Russia).—The principal pyrite deposits of European Russia are on the eastern slope of the Ural Mountains, the better-known being in the vicinity of Sverdlovsk. All contain copper and occur in metamorphic and volcanic rocks.

Important pyrite deposits occur in the Caucasus Mountains. The most important are of the disseminated and massive type in Jurassic quartzites; zinc, precious metals, and selenium accompany the pyrite.

Siberian pyrite reserves occur in three widely separated areas: (1) Altai Mountains. These are the most important deposits and are associated with granites, to which they owe their origin. They are in the form of lenses 100 to 400 m. in length, 1 to 20 m. in width, and 70 to 200 m. in depth. The pyrite also carries zinc or zinc and lead, with values in gold and silver in both types of deposits. The most important occurrences are those of Bielousovsky, Salair, and Riddersky. (2) The Kirghiz steppe, the most important deposit being that of Mai Kain near Semipalatinsk. (3) Central Siberia, the most important of these little-known deposits being the Mainsky.

Other Countries.—Smaller amounts of pyrite are mined in Algeria, Australia (Tasmania), Chosen, Czechoslovakia, Finland, Poland, Rumania, Southern Rhodesia, Union of South Africa, United Kingdom, and Yugoslavia.

INDUSTRIAL USES

For many years before the discovery of the Louisiana sulphur deposits, the largest part of the sulphuric acid (H_2SO_4) requirements of the world was met by the United States production from pyrites. It has been estimated that at present more than 50 per cent of the world consumption of this acid is derived from brimstone (crude sulphur).

Practically the entire output of pyrites in the United States (the largest consuming country) is used in the manufacture of sulphuric acid. In some countries of Europe and to a very

minor extent in Canada, pyrites is the basis for the production of sodium sulphite, utilized in the manufacture of wood pulp. In acid manufacture, pyrites competes with native sulphur and with by-product acid derived from the smelting of ores, while in the wood-pulp industry (paper making) it competes with native sulphur only.

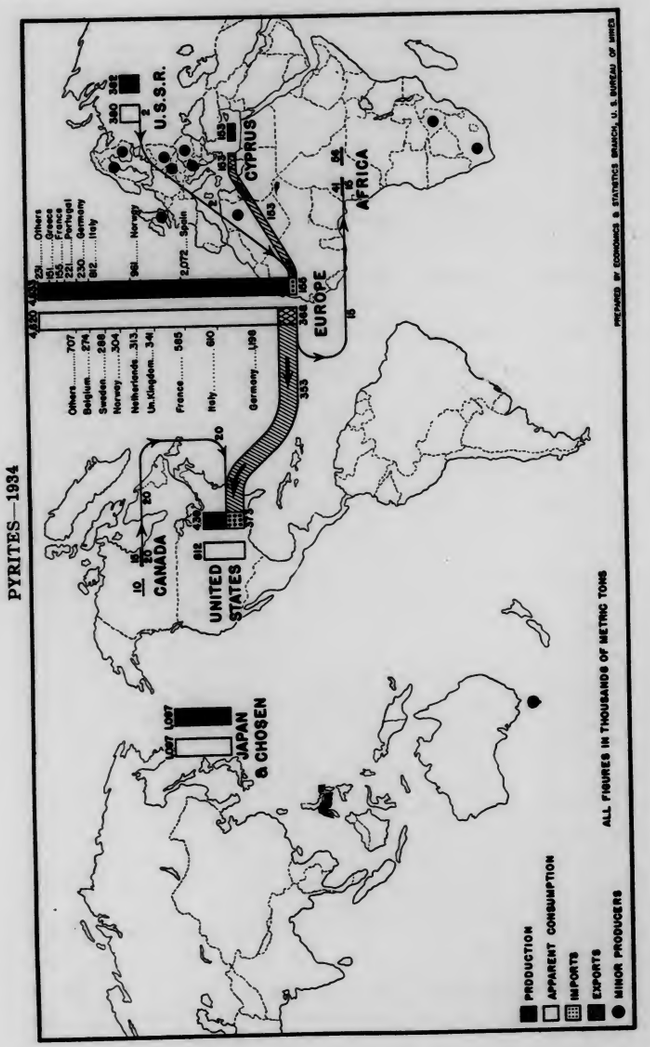
SUBSTITUTES

For practically all commercial needs, crude sulphur is an adequate substitute for commercial pyrites.

WORLD PRODUCTION OF PYRITES (INCLUDING CUPREOUS PYRITES), 1932–1934
(In Metric Tons)

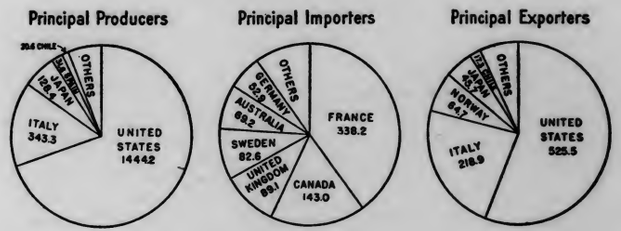
Country[1]	1932		1933		1934	
	Gross weight	Sulphur content	Gross weight	Sulphur content	Gross weight	Sulphur content
Algeria	21,160	9,730	16,090	7,401	13,600	6,270
Australia (Tasmania)	278	[2]	1,522	[2]	12,223	[2]
Canada	47,210	23,547	53,164	25,563	10,040	4,990
Chosen	7,130	[2]	14,518	[2]	40,024	[2]
Cyprus[3]	180,481	90,240	213,340	106,670	152,606	76,303
Czechoslovakia	15,640	6,569	15,426	6,479	17,920	7,527
Finland	36,240	16,670	37,798	16,612	71,167	32,950
France	191,600	87,130	168,422	77,000	155,113	69,091
Germany	175,216	75,344	189,647	81,575	230,149	99,065
Greece	86,767	42,169	184,442	89,748	150,950	72,998
Italy	516,961	237,699	732,701	335,724	812,396	379,605
Japan	726,073	290,429	852,019[4]	340,808[4]	1,057,266	422,906
Norway	727,020	318,990	864,576	382,738	960,898	424,718
Poland	219	96	1,228	540	11,996	5,278
Portugal	237,637	111,689	210,660	100,000	220,869	103,808
Rumania	5,350	[2]	12,112	[2]	4,001	[2]
Southern Rhodesia	272	109	11,080	4,471	11,714	4,674
Spain	2,146,441	901,505	2,223,472	933,858	2,072,413	817,413
Sweden	71,534	27,963	86,295	33,489	100,572	40,084
Union of South Africa	3,436	[2]	3,664	[2]	15,767	[2]
U.S.S.R. (Russia)	[2]	[2]	378,200	[2]	381,900	[2]
United Kingdom	1,008	[2]	1,150	[2]	2,179	[2]
United States	192,748	67,498	288,874	109,508	439,466	170,336
Yugoslavia	15,718	6,503	20,077	9,035	22,513	10,131

[1] In addition to countries listed, Belgium reports production, but figures are not shown separately.
[2] Data not available.
[3] Exports.
[4] Incomplete; output of more important mines only.



SULPHUR — 1934

(all figures in thousands of metric tons)



Native sulphur[1] occurs in the vicinity of volcanoes, in stratified deposits of Tertiary age, and in salt domes.

July 31, 1932, witnessed the dissolution of the marketing agreement between the American exporters and the Sicilian Sulphur Consortium, which had been in effect since 1923. In July 1934 a new agreement was negotiated. This agreement provides for allocation and sales in the world markets, exclusive of North America and Italy.

PRINCIPAL DEPOSITS

United States.—World reserves of sulphur are estimated to be 170,000,000 to 177,000,000 tons, of which 140,000,000 tons are in Texas and Louisiana.[2] Thus it will be seen that by far the largest part of the deposits is in and controlled by the United States. Louisiana and southeastern Texas are the most important producers. The deposits are associated with gypsum and oftentimes with salt. Sand and clays slope outward, away from a buried plug or dome of salt. This concealed dome has a cap or crown composed of limestone and gypsum and very often contains more or less sulphur. Some nine salt domes have

[1] STUTZER, O., Die wichtigsten Lagerstätten der Nicht-Erze, vol. 5, Schwefel-Graphit-Jod-Bor-Magnesit-Talk, 1933, pp. 1–97.

[2] BAYLEY, W. S., Nonmetallic mineral products, New York, 1930, p. 499.

produced sulphur at depths of 600 to 1,000 ft. The sulphur is obtained very cheaply by the Frasch process, which consists of pumping superheated steam down through large-diameter pipes and melting the sulphur in the rock. The sulphur is then drawn by means of compressed air to the surface, where it solidifies in bins to be later blasted down and loaded on cars. The product is very pure, containing 99.5 per cent sulphur.

Sulphur of the solfataric type is mined at Sulphurdale, in central Utah. Sulphur has also been mined in Wyoming, Colorado, and Nevada.

Italy.—The sulphur deposits of Italy are in Sicily in a region 160 to 179 km. in length and 85 to 90 km. in width. Exploitation dates back to ancient times. The sulphur occurs in sediments of Tertiary age, that is, in clayey limestones associated with gypsum and marl and containing strontium-bearing minerals. The sulphur-bearing rock forms enormous lenses rather than beds. Generally, there are several layers of sulphur, which form incrustations in small cavities or thin beds interlaminated with the country rock. Minable ore must contain 8 per cent sulphur; the average ore carries about 20 to 21 per cent sulphur and ranges upward to 80 or 90 per cent. Mining and refining methods are not very high in efficiency. Production is limited by law, the government guaranteeing a preestablished minimum price for the product within the quotas established for each mine.

Deposits are also located on the Italian mainland in Romagna, Marche, Campania, and Calabria, where the sulphur occurs as horizons up to 15 m. in thickness in Tertiary sediments. The sulphur content ranges from 10 to 25 per cent.

Japan.—The sulphur deposits are related to volcanoes which extend in a belt from Taiwan to Japan Proper. Four types of occurrences are distinguished: (1) incrustations and impregnations of solfataric wall rock on the Kyushu, Honshu, and Hokkaido Islands; (2) mixed mud and sulphur derived from volcanic eruptions; (3) sulphur deposits in an old crater lake (Hokkaido Island); and (4) sulphur deposits of hot springs, which are only of medicinal importance.

Spain.—The Albacete sulphur district of Spain produces over half the Spanish output, but sulphur mines are also operating in the Provinces of Murcia and Granada. The sulphur forms bedded deposits in Tertiary sediments.

Chile.—The Chilean sulphur deposits are located on the walls or craters of the volcanoes of the high Andes. Sulphur deposits are found in northern Chile on the Tacora, Paucarany, Cerro Porquesa, Ollague, Aucanquilcha, and Copiapó volcanoes, and in southern Chile on the Tinguirirca volcano. Mining and refining methods are very primitive. Lack of transportation facilities has hampered development.

Other Countries.—Sulphur mines have been worked at Swoszowice, Galicia, Poland, and at Petrovsk, Dagestan, Union of Soviet Socialist Republics. Extensive deposits of sulphur are reported in the Kara Kum Desert east of the Caspian Sea. The most important occurrences in Mexico are those of Los Cerritos, between Tampico and San Luis Potosí. Small amounts of sulphur are produced in Argentina, Bolivia, China, Ecuador, Greece, Netherland India, New Zealand, Southern Rhodesia, and Turkey.

A small amount is produced as a by-product from the smelting of nonferrous ores. Part of the sulphur required is supplied as sulphuric acid obtained from the reduction of sulphides of iron ores, such as pyrites and pyrrhotites. Most of the sulphur consumed in industry is converted into sulphur dioxide, the base for the manufacture of sulphuric acid.

INDUSTRIAL USES

The major uses of sulphur are in the manufacture of commercial fertilizer, the distillation of petroleum, the production of acids and chemicals, and in steel pickling, storage batteries, metallurgy, pigments, explosives, and textiles. The largest consuming use of sulphur is in the manufacture of sulphuric acid, which in turn is used principally for the production of commercial fertilizers. Other uses are for galvanizing, tinning, and enameling, where pickling is necessary in the manufacture of these commodities. Sulphur is required for the production of certain petroleum products; it is an ingredient of the solution used in storage batteries; in the refining of copper as an electrolyte; and for the manufacture of certain chemicals and drugs.

Reference

RIDGWAY, R. H.: Sulphur: General information, *U. S. Bur. Mines, Inf. Circ.* 6329, 1930, 55 pp.

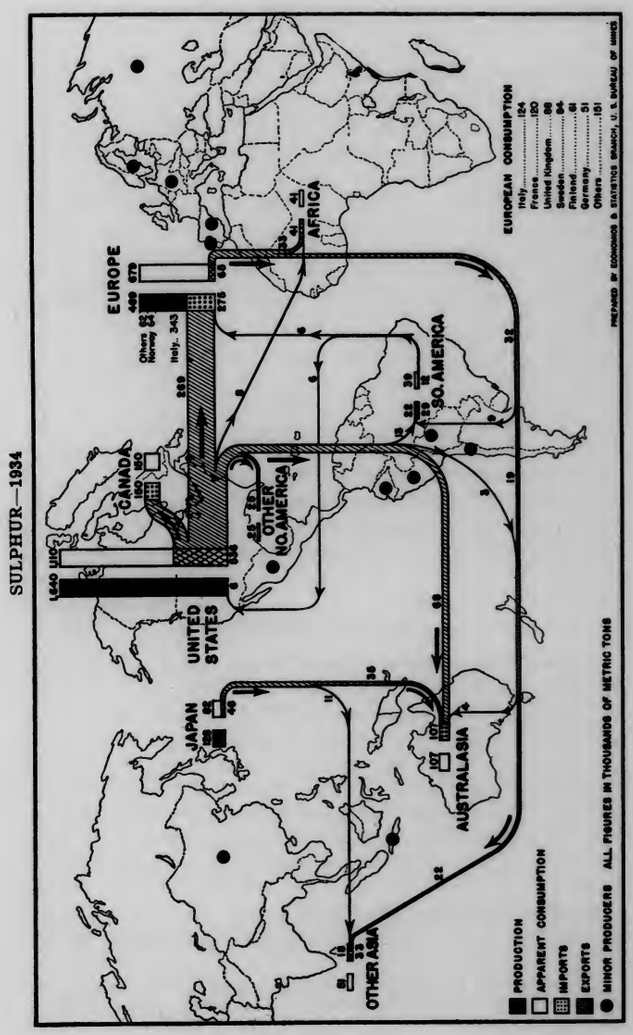
PRODUCTION OF SULPHUR IN THE PRINCIPAL PRODUCING COUNTRIES, 1932–1934
(In Metric Tons)

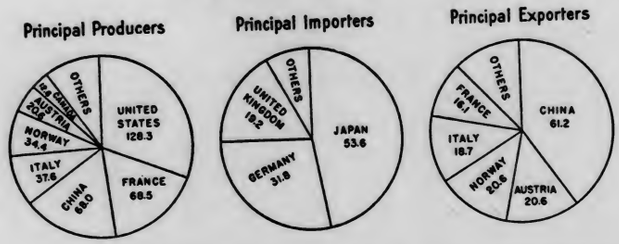
Country	1932	1933	1934
Chile	11,959	12,759	20,683
Italy[1]	349,976	376,623	343,388
Japan[2]	84,530	114,426	128,424
Spain[3]	8,243	27,614	31,629
United States	904,732	1,428,630	1,444,288

[1] In addition, the following quantities of ground rock are reported: 1932, 25,522 tons; 1933, 24,963 tons; 1934, 22,170 tons.

[2] In addition, the following quantities of sulphur rock are reported: 1932, 2,633 tons; 1933, 2,700 tons; 1934, similar data not available.

[3] Refined sulphur, exclusive of that made from imported crude sulphur.





Talc[1] and soapstone are formed by the alteration of magnesian rocks, whether sedimentary, as the dolomites, or igneous, as the peridotites. *Steatite* is the term applied to the very fine grained variety of talc and *soapstone* is the term applied to the coarsely crystalline greenish or gray-bluish rock containing impurities with the talc.

PRINCIPAL DEPOSITS

United States.—From deposits in the region around Gouverneur, St. Lawrence County, New York is the largest producer of talc and ground soapstone in the United States. Central and eastern Vermont is the next largest producer. California producers talc in San Bernardino and Inyo Counties. Talc is mined in western North Carolina; most of the Carolina talc is ground. The Virginia deposits occur in a narrow belt 30 miles long, extending from Nelson into Albermarle County. The talc occurs in the form of soapstone, which is largely cut into slabs.

France.—Outside of the United States, France is the largest producer of talc. The French deposits are situated on the

[1] HIMMELBAUER, A., Talk, in Stutzer, O., Die wichtigsten Lagerstätten der Nicht-Erze, vol. 5, pp. 320–370, ill. Berlin, Gebrüder Borntraeger, 1933.

northern slope of the Pyrenees Mountains in the Department of Ariège.

China.—The greater part of the talc production of China comes from the Tsintien region, Chekiang Province, and the provinces of Hopeh and Fukien. The talc occurs in the form of steatite, which can be carved into ornaments or utensils. A very high grade talc is found near the town of Tashih Chiao, South Manchuria, on the South Manchurian Railway.

Italy.—The Alpine deposits of the Piedmont Province supply about 90 per cent of the Italian production. The talc is especially pure. Talc is also mined in Sardinia west of Orani.

Norway.—The talc production of Norway has tended to increase. The deposits are near Vaagas and Sel in Gudbransdalen. Similar deposits are reported in Nordland and Framfjord. Pure talc is mined at Arnefjord in Sognefjord and at Oisteso south of Bergen.

Austria.—Talc deposits are found in the slate belt of the central Alps of Austria. The deposits are of three types: (1) talc associated with magnesite; (2) talc associated with phyllites or very fine grained slates; and (3) talc slates associated with serpentines. The most important Austrian deposit is that of the second type at Mautern, Styria. Other deposits are worked in the central Alps of Salzburg and Tirol.

Canada.—In Canada talc is mined at Madoc, Hastings County, Ontario.[2] Soapstone deposits are worked intermittently in southern Quebec.

British India.—The talc production of British India is centered around Jubbulpore, Central Provinces, where steatite occurs in a limestone. Steatite is also mined in Bihar and Orissa, Madras, and in the United Provinces.

U.S.S.R. (Russia).—In the Union of Soviet Socialist Republics the talc deposits occur associated with metamorphic rocks in a belt extending from Zlatousk to Alapaevsk in the Ural Mountains. The principal source of production, however, is the Sverdlovsk region. Other deposits are found in Karelia and the Caucasus region.

Other Countries.—Talc is also produced in Australia, the principal production coming from South Australia. Other

[2] WILSON, M. E., Talc deposits of Canada, *Can. Dept. Mines, Econ. Geol. Series* 2, 1926, 149 pp.

countries producing talc are Egypt, Finland, Greece, French Morocco, Rumania, Spain, Sweden, Union of South Africa, United Kingdom, and Uruguay.

INDUSTRIAL USES

More than 60 different industrial uses of talc can be noted, but of these many are at present of minor importance. The largest uses are in the manufacture of paper, paint, prepared roofing, rubber, textiles, and toilet powder. In the paper industry talc is used as a filler and is said to be superior to china clay for many of these uses. In paint, talc is used as an inert extender but has to meet keen competition with such materials as silica and other finely ground mineral substances. Talc is used chiefly as a dusting agency in the manufacture of rubber, and also as a filler in some of the lower grades of rubber goods. Ground talc is also employed as a filler in soap, foundry facings, wire-insulating compounds, and gypsum and other wall plaster and as an absorbent for oil, odors, and organic colors. An important but minor application considered from the standpoint of tonnage consumption is its use in the manufacture of gas-burner tips and electric insulators.

Because of its softness soapstone can be sawed or carved and is used extensively for laboratory tanks and tables, electrical switchboards, fireless cookers, and sanitary appliances. Soapstone dust is used for conditioning cement, as an insecticide carrier, for dusting coal in the mines, and as a roofing material similar to granular roofing talc. Bricks for oven linings are made from soapstone dust.

The uses of this commodity for military purposes are similar to those of the industrial world.

SUBSTITUTES

In the manufacture of paper and insulators there is no known substitute that satisfies the requirements with the same degree of efficiency. Substitutes can be found for almost all other uses.

WORLD PRODUCTION OF TALC AND SOAPSTONE, 1932–1934
(In Metric Tons)

Country[1]	1932	1933	1934
Australia:			
New South Wales	293	398	341
South Australia	1,071	1,399	1,419
Tasmania	5	9	6
Austria (exports)	17,289	20,871	20,673
Canada[2]	10,980	13,772	12,663
China (Manchuria)	44,316	62,430	[3]
Egypt	232	2,531	2,603
Finland	1,625	1,288	1,586
France	68,500	[3]	[3]
Germany (Bavaria)	3,197	5,107	6,934
Greece	617	1,272	118
India, British	6,617	17,322	9,525
Italy	32,404	34,487	37,671
Morocco, French (exports)	837	526	788
Norway	13,536	19,885	34,474
Rumania	1,798	1,112	1,933
Spain	6,574	10,064	5,285
Sweden	4,525	4,396	6,501
Union of South Africa (Transvaal)	251	271	218
United Kingdom	262	169	.....
United States	111,784[4]	148,840[5]	128,310[5]
Uruguay	2,625	1,270	879

[1] In addition to the countries listed, talc is produced in Argentina, Brazil, and the U.S.S.R. (Russia), but data on production are not available.

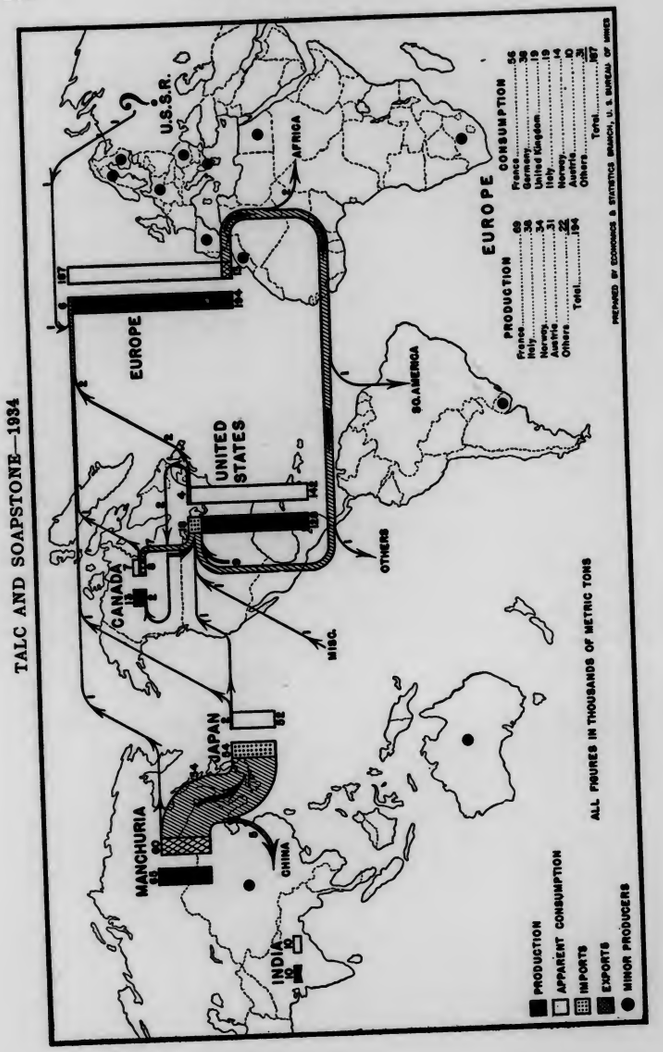
[2] Excluding soapstone, which is reported only by value and was as follows: 1932, $46,751; 1933, $47,680; 1934, $44,297. Soapstone is sold in the form of both blocks and powder.

[3] Data not available.

[4] Figures represent sales of talc only. Bureau of Mines not at liberty to publish figures for soapstone.

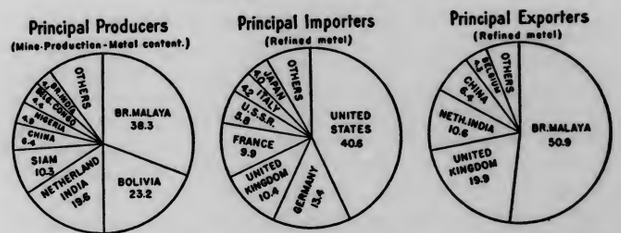
[5] Figures represent total mine production of talc and soapstone.

TALC AND SOAPSTONE—1934



TIN – 1934

(all figures in thousands of metric tons)



All tin[1] deposits of the world are shown to be genetically related to igneous rocks, such as granite and rhyolite. Associated with tin-bearing minerals are lead, silver, bismuth, and tungsten. The commercial minerals of tin are stannite (Cu_2FeSnS_4), franckeite ($3PbSnS_2 + Pb_2FeSb_2S_8$), cylindrite ($3PbSnS_2 + SnFeSb_2S_8$), and cassiterite (SnO_2). Varieties of cassiterite are "wood tin" and "toad's-eye tin" or cassiterite worn smooth by the action of water. Tin oxide or cassiterite is chemically quite stable and not subject to alteration, as is the case with the complex tin sulphide minerals. The high specific gravity of cassiterite, 6.8 to 7.1, lends itself to concentration by gravity. Broadly, the tin obtained commercially from the tin deposits, except for the complex tin sulphide lode deposits of Bolivia, is in the form of cassiterite. Roughly about three-fourths of the tin produced is derived from placer deposits formed by the weathering and accumulation of debris from granites and quartz veins.

Lode mining of tin is conducted in the manner employed in the mining of all vein deposits. The vein matter must in general carry 1 to 2 per cent tin to be commercial. The mining of detrital material is accomplished by panning, hydraulicking, or by dredging. The concentrate obtained carries 60 to 75 per cent metallic tin.

[1] Subcommittee of the House Committee on Foreign Affairs, Tin investigation; Report: Parts 1–3, 1935, 1111 pp.

The high prices of tin during 1926–27 resulted in overproduction of this metal in 1928. During 1928 the Tin Producers' Association was organized to control the output of the tin mines. This control failed owing to the onset of the general business depression. In 1930 an effort was made to organize a legally enforceable curtailment program. On Mar. 1, 1931, the International Tin Committee was organized under the sponsorship of the governments of British Malaya, Bolivia, Netherland India, and Nigeria. This agreement was to run for 3 years. The 1929 output was used as the base, the committee regulating production by granting the signatories the right to produce varying percentages of the standard. At one time the production was reduced to one-third of the 1929 output. The International Cartel later included the governments of Siam, Belgian Congo, Indo-China, the United Kingdom, and Portugal. The quotas for these countries were more liberal than those set for the original signatory countries. This agreement was extended to Dec. 31, 1936.

PRINCIPAL DEPOSITS

Malay States.—Approximately one-third of the world's tin is obtained from the Malay States, particularly the Federated Malay States; only a fraction of the product is derived from the Unfederated Malay States. The cassiterite occurs in layers of detrital gravel derived from the weathered tin-bearing granite. Lode deposits are also operated, the Pahang Consolidated mine being one of the world's greatest tin mines. Several methods of mining are employed—open cutting of bed rock, gravel pumping, hydraulicking, dredging, shafting, and panning. During the last 20 years, many of the richer deposits have been exhausted. The old Chinese system of employing many thousand laborers in open cuts has been abandoned.

Bolivia.—Virtually all the tin won in Bolivia comes from lodes at high elevations in the very mountainous Andean country. The tin ores are widely distributed and are related to the occurrence of granites and quartz-porphyries. Some 10 districts produce tin, the most important of these being Potosi, Uncia, and Llallagua. The future of tin mining in Bolivia seems to indicate a gradual decline in production as commercial exhaustion is approached.

The importance of the tin industry to Bolivia may be judged from the fact that three-quarters of the government's revenue is derived from this source. Political and economical difficulties have resulted in a notable decrease in production.

Netherland India.—Alluvial cassiterite deposits of Netherland India are mined on the islands of Banka, Billiton, and Singkep, which are adjacent to the Federated Malay States. Lode deposits are also mined on the Island of Billiton.

Siam.—The granite mountain ranges of lower Burma continue southward into western Siam. The greater part of the tin is mined from the alluvial flats adjacent to this granite range by dredging. The regularity of the bed rock in Siam assists in making the deposits quite easily and profitably worked. Stream beds and eluvial deposits are also productive.

China.—Tin is won in southern China in the provinces of Yunnan, Kwangsi, and Hunan. The Kochiu mines in Yunnan are the most important. The deposits are genetically related to quartz veins and granites. The alluvial deposits are mined by primitive methods, which depend largely upon rainfall.

Nigeria.—In Nigeria cassiterite occurs sporadically distributed over an area of 10,000 sq. mi., the principal deposits being in the Province of Bauchi. These deposits are of detrital character. The cassiterite is not evenly disseminated throughout the wash and dredging has so far not been commercial. The method of mining has been confined to sluicing and panning.

British India.—The tin ores of Burma are closely associated with the granite mountain ranges which pass southward through Siam into the Malay Peninsula. In all cases cassiterite is closely associated with wolframite, sulphide minerals, and so on. Alluvial and lode mining are carried on in some five districts. The Tavoy district is the principal producer, followed in order by the Southern Shan States and the Mergui district, all in Burma.

Belgian Congo.—This country is a newcomer to the list of large tin producers. Detrital and lode deposits of tin are found in Katanga in a mineralized zone about 250 miles in length. Stanniferous deposits extend from Kivu into Tanganyika Territory. The mandated territory of Ruanda—Urundi is now producing a considerable amount of cassiterite. Tin production of Belgian Congo has shown a material increase in recent years.

Australia.—Tin ores are widely distributed in Australia, occurring in the provinces of New South Wales, Victoria, Queensland, Western Australia, and Tasmania. Lode and alluvial deposits are here associated with granites and quartz-porphyries. Production has remained at a relatively constant level for many years.

United Kingdom.—Cassiterite has been mined in the Cornwall district of the United Kingdom in southwestern England since the days of antiquity. The lodes are closely associated with several granitic intrusives. In addition to tin, considerable amounts of copper, lead, zinc, and tungsten have been mined from the same or adjacent veins. Many of the mines have been worked to great depths and only a few could long survive a period of sustained low tin prices.

Japan.—Tin ores occur in Japan in the provinces of Tajima, Satsuma, Bungo, and Mino, of which the Akenobe district of Tajima Province on the Island of Honshu is the most important. Here lode deposits occur genetically related to acidic and intermediate rocks. Although production has increased in Japan it has of late years reached a more nearly stationary position.

Indo-China.—Alluvial and lode deposits are worked in the Pic-Oac district of Indo-China. The cassiterite of the lode deposits is associated with wolframite. The production has remained practically constant for several years.

Alaska.—Alluvial and lode deposits of cassiterite have been discovered in the Seward Peninsula, York, and Lost River districts, Alaska.

United States.—Cassiterite has been mined in the United States from the pegmatite deposits in the Black Hills of South Dakota and from lode and alluvial deposits of the southern Appalachian region. Despite efforts to stimulate the production of tin, output remains almost negligible.

Other Countries.—A small amount of cassiterite is produced in Mexico from a number of localities. Northern Portugal is a small producer of cassiterite. Transvaal is the principal source of cassiterite in the Union of South Africa, although a small amount of tin ore is produced in the Cape Province.

Countries producing less than 500 tons of cassiterite per annum are as follows: Argentina, French Cameroun, French Morocco, Northern Rhodesia, Southern Rhodesia, South-West Africa, Spain, Straits Settlements, Swaziland, Tanganyika, and Union of South Africa.

SMELTING

The most important tin-smelting centers of the world are in the British Empire at Liverpool, Singapore, and Penang, whence the British and Bolivian concentrates are consigned for reduction. Besides these smelters the Dutch have smelters at Arnhem, and the Belgians at Hoboken. Tin smelters are located also in Germany and China. The location of the smelting plants at great distances from the mines is not an important factor in the industry owing to the low ratio of the transportation charges on the concentrates to the value of the metal. Tin is not being smelted in the United States at present, but from 1916 to 1924 some Bolivian tin ores were smelted here.

INDUSTRIAL USES

Tin has been used by the human race for so many centuries that it may be considered essential to the maintenance of our present-day world. No one knows when tin was first used. It is thought that the dawn of the Bronze Age (bronze is composed of 87 per cent copper and 13 per cent tin) lies between the years 3500 and 4500 B.C. The application of tin to the many essentials and conveniences of life may be realized by mentioning some of the outstanding adaptations of this metal to our mechanical needs. Annually, hundreds of millions of tin containers are used in the preservation and transportation of food. All civilized nations are dependent in part on a supply of tin to meet this demand. No ship, train, road vehicle or airplane moves without tin. The telephone, telegraph, wireless, gas supply, water supply, electric light—all require this metal.

The largest consuming use of tin is in the manufacturing of tin plate and terneplate. Tin plate is used for the making of containers for the preservation of food stuffs, as well as for gasoline, oil, tobacco, and beer. Terneplate is used for automobile tanks, firedoors, metal furniture, and roofing.

The next important consuming use is as solder for joints and welding many metals.

Other uses of tin are as babbitt and bronzes, foils, and collapsible tubes and in the chemical industries. Almost all the so-called white metals contain tin as an alloying metal.

SUBSTITUTES

For the main uses of tin there is no efficient substitute. Tin cans or tin containers may be replaced by glass and paper for the preservation of certain foods. Many nonmetallic products, as well as copper and zinc coating are competitors of tin and terne plate. These are used for roofing, siding, and other covering applications. Lap-welding and die stamping of tin cans have decreased the demand for solder (alloy of lead and tin). In electrical work where resistance to high tension is required, silver solder and brazing may be substituted for tin. Cadmium is also proving to be a satisfactory substitute for tin in some solders.

During the last 5 years, coincident with the ever-increasing use of substitutes for tin has been the demand of the petroleum industry as well as beverage manufacturers for tin containers. These demands have practically offset the loss of the market for tin by substitution.

WORLD MINE PRODUCTION OF TIN, 1932–1934
(In Metric Tons)[1]

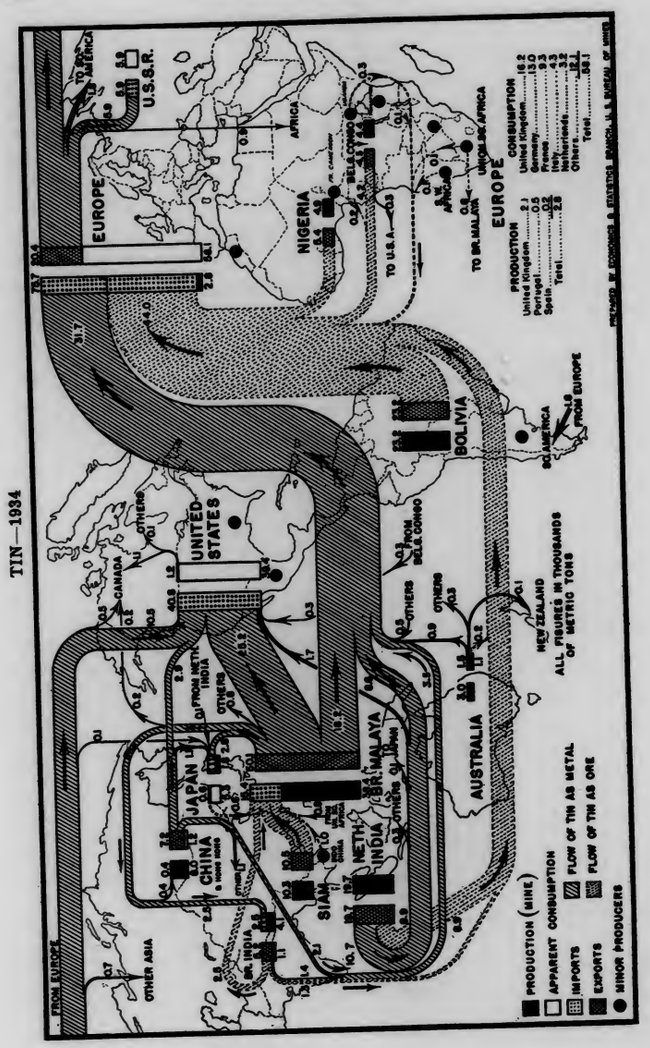
Country	1932	1933	1934
Australia	2,172	2,855	3,034
Belgian Congo	[2]	1,601	4,426
Bolivia[3]	20,919	14,957	23,201
China[3]	2,041	9,637	6,442
India, British	3,219	3,204	4,126
Indo-China	1,026	1,055	1,150
Japan	1,582	1,563	1,500[4]
Malay States:			
Federated Malay States[3]	28,818	24,306	36,969
Unfederated Malay States	1,363	938	1,370
Mexico	751	[2]	631
Netherland India	17,058	12,811	19,669
Nigeria	4,389	3,815	4,942
Portugal	[2]	[2]	532
Siam	9,425	10,500	10,320
Union of South Africa	549	548	579
United Kingdom	1,358	1,567	2,031
Other countries[5]	1,900	1,900	2,000
Total	97,000	91,000	123,000

[1] Tin content of ores produced, except as otherwise noted.
[2] Less than 500 tons; included under "Other countries."
[3] Exports.
[4] Approximate production.
[5] Includes countries producing less than 500 tons.

WORLD SMELTER PRODUCTION OF TIN, 1932–1934
(In Metric Tons)[1]

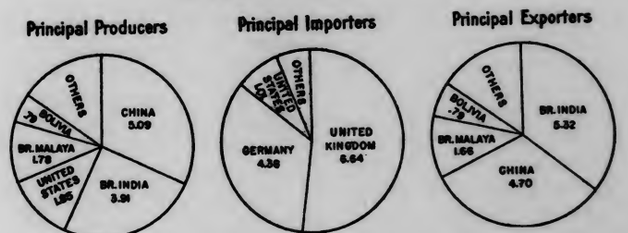
Country[2]	1932	1933	1934
Australia	1,989	2,398	2,367
Belgium (estimated)	800	2,700	4,000
British Malay[3]	50,747	47,695	50,424
China	8,017	7,700	8,100
France	188	51	.....
Germany	1,901	1,659	2,191
Italy	7	7	187
Japan	1,003	965	1,182
Netherlands (estimated)	3,600	5,100	13,626
Netherland East Indies (exports)	8,221	8,933	10,675
Norway	246	163	177
Portugal	75	85	40
United Kingdom	28,957	18,492	26,925
Total	106,000	96,000	120,000

[1] Adapted from figures as published by Imperial Institute, London, converted to metric tons on the basis of 1 long ton = 1.01605 metric tons.
[2] Secondary tin recovered in the United States (as metal, in alloys, and in chemical compounds) was as follows: 1932, 13,381 tons; 1933, 20,049 tons; 1934, 22,589 tons.
[3] Exports plus difference between "carry-over" at end and beginning of the year.



TUNGSTEN — 1934

(all figures in thousands of metric tons)



The principal tungsten-bearing minerals are wolframite, $(FeMn)WO_4$, 76.4 per cent WO_3; ferberite, $FeWO_4$, containing approximately 70 per cent WO_3; hübnerite, $MnWO_4$, 76.6 per cent WO_3; and the rarer scheelite $CaWO_4$, 80.6 per cent WO_3. Tungsten ores are commonly found associated with igneous rocks, such as granites, acid pegmatites, and acid porphyries. The deposits may be found encased in the igneous rocks or within slates or quartzites at or near the contact of igneous rocks with sedimentaries. Tungsten deposits are generally classified as to their occurrence as follows: segregation deposits, pegmatites, veins, replacement, contact metamorphic, and placers. Recently the largest part of the world production has probably been derived from the placers or detrital ores of China. Practically all tungsten ores must be concentrated before being shipped. The commercial grade of the concentrates is 60 per cent tungstic acid (WO_3). The penalties as to impurities are not vigorously enforced, but ores must be low in phosphorus and copper, with little or no arsenic, sulphur, tin, or bismuth.

PRINCIPAL DEPOSITS

China.—Southern Kiangsi, southeastern Hunan, northern Kwangtung, and northeastern Kwangsi, China, are the principal producing regions of tungsten. On Nov. 24, 1933, "The Kwangtung Provincial Government Monopoly Bureau of Wolfram Ore"

was formed, and the world supply and price have since been controlled by this organization. The very low labor cost permits exploitation of these deposits, despite high transportation and taxation charges.

British India.—The largest tungsten deposits of British India are located in the Tavoy region of Burma. Smaller deposits are to be found in the Southern Shan States adjoining the tungsten-bearing Yunnan Province of southern China. The production of the Southern Shan States comes from one property (Mawchi), where the mined ore contains wolfram, scheelite, and tin. Wolframite-cassiterite veins are associated with the granite, forming the core of the mountain ranges extending from Burma southward into Siam and the Malay Peninsula. Before the war Burma was the largest producer of tungsten in the world. During the period, 1919–1928, production practically ceased, during the years 1929–1933 mining activities increased.

Malay States.—The Federated Malay States, with one scheelite mine in the Perak area near Ipoh, surpass the production of the Unfederated Malay States where the principal production is in the State of Trengannu.

United States.—Production in the United States has been derived mainly from Colorado, California, and Nevada. The ores are chiefly of the low-grade vein type, but placer deposits are known.

Bolivia.—Certain tin-bearing lodes of Bolivia, such as those of Colquiri, Yangas, and Khami, also contain tungsten-bearing minerals. During the war these deposits were of considerable importance.

Portugal.—Tungsten deposits are located in Beira Baixa Province, Portugal, between the Duro and the Tagus Rivers. The tungsten minerals are associated with tin in lodes and alluvial deposits.

Indo-China.—Wolframite occurs associated with cassiterite in the tin deposits of upper Tonkin, Indo-China, where the tungsten is largely recovered as a by-product.

Other Countries.—A small amount of tungsten is produced in Australia (New South Wales, Northern Territory, Queensland, and Tasmania), Chosen, Japan, Mexico, New Zealand, Siam, Southern Rhodesia, South-West Africa, Spain, and the United Kingdom (Cornwall district of England).

INDUSTRIAL USES

Tungsten is one of the metals which may be called modern in the sense that it was probably unknown to the ancients and came into use largely during the last century. One of its greatest contributions to industry is in the manufacture of high-speed tool steel. Tungsten imparts to steel certain characteristics that make it extremely valuable in the machining of metals. The efficiency of the electric light or electric lamp may be attributed to the filament of tungsten which has replaced all other filaments.

The use of tungsten in high-speed tool steel exercises an important influence upon industries of all kinds. It increases the speed and reduces the cost of all processes which require the cutting of metal. With tools of such steel a deeper and wider cut may be taken and yet this may be done at a much higher speed than would be practicable if tools of ordinary steel were used. In the cutting of metals, heat is generated. This heat destroys the temper of ordinary steels and they become soft. The mere presence of tungsten in steel makes it hard, and steels of this type are known as "self-hardening"; yet this hardness is not destroyed by high temperatures. Tungsten is also used in the manufacture of springs for railway cars, as well as forming a component part in many steel alloys.

SUBSTITUTES

There are several substitutes known for tungsten. In tool steel, molybdenum may be used, but there are many difficulties encountered in the use of molybdenum steel, which do not apply to tungsten.

Reference

VANDERBURG, W. O.: Tungsten: Part I *U. S. Bur. Mines, Inf. Circ.* 6821, 1935, 30 pp.

WORLD PRODUCTION OF TUNGSTEN, 1932–1934
(In Metric Tons)[1]

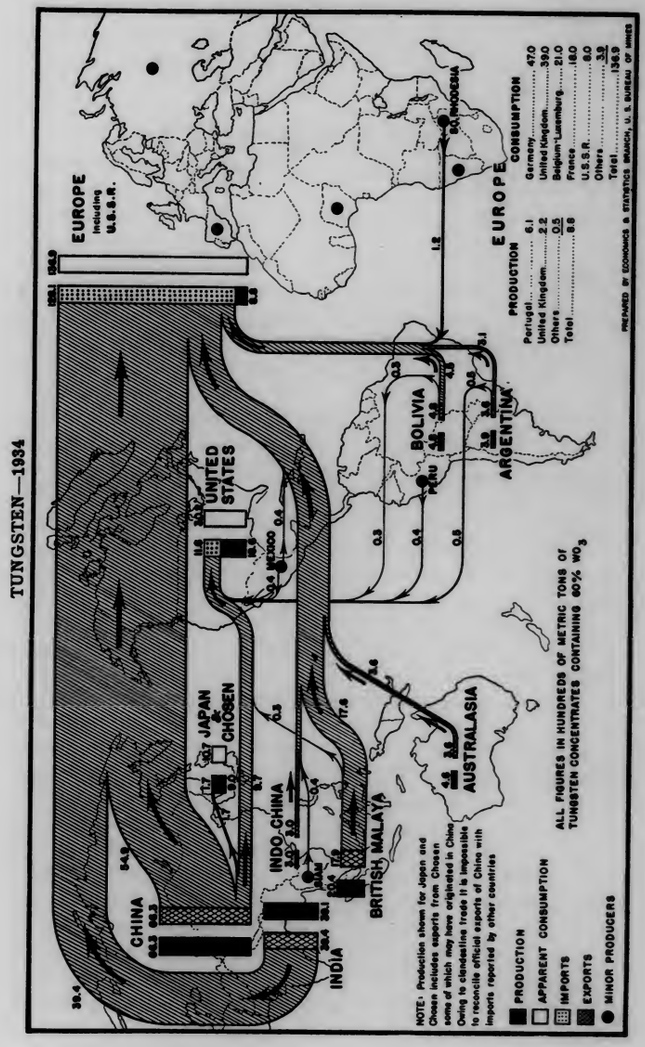
Country[2]	1932	1933	1934
Argentina	6	.....	392
Australia:			
New South Wales	27	[3]	59
Northern Territory	15	13	89
Queensland	8	14	41
Tasmania	.....	123	230
Bolivia[4]	686	240	475
China	2,249	6,000	5,099
Chosen	62	144	399
Germany (Saxony)	.....	.....	1
Great Britain (Cornwall)	2	12	223
India, British	2,226	3,056	3,913
Indo-China (Tonkin)	247	250	300
Japan	22	31	70
Malay States:			
Federated Malay States	378	1,188	1,695
Unfederated Malay States	175	91	90
Mexico	.....	.....	80
Netherland India	.....	.....	1
New Zealand	9	19	39
Nigeria	.....	.....	5
Peru	.....	.....	12
Portugal	272	358	610
Siam	.....	.....	36
Southern Rhodesia	14	33	117
South-West Africa	.....	3	18
Spain	43	46	49
United States	359	812	1,859
Total	6,800	12,400	15,900

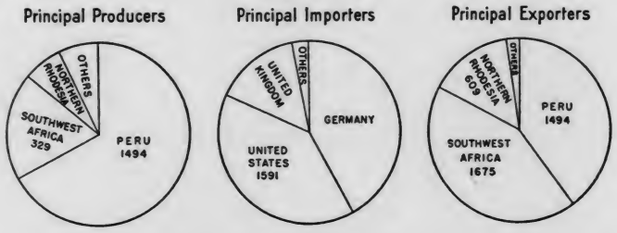
[1] Concentrates containing 60 per cent WO_3.

[2] In addition to the countries listed, tungsten ore is produced in the U.S.S.R. (Russia), but no data of production are available for the period under discussion.

[3] Less than 1 ton.

[4] Exports.





Vanadium occurs in nature as patronite (VS_4) and in several minerals formed by its oxidation: vanadinite, $Pb_4(PbCl)(VO_4)_3$, descloizite, $(PbZn)_2(OH)VO_4$, and related minerals (vanadates of lead containing more or less copper and zinc), which are found in oxidized parts of lead, lead-zinc, and lead-copper deposits in which the copper and zinc are combined with the lead; vanadium also occurs in carnotite, roscoelite, and in small quantities in ilmenite, asphaltites, and some iron ores, such as the minette ores of France.

Vanadium is smelted by roasting the sulphide and fusing the product with a sodium salt to form sodium vanadate, which is smelted with iron in an electric furnace or by an aluminothermic process to ferrovanadium containing 35 to 40 per cent vanadium. In the case of vanadinite the lead segregates itself as the metal, the vanadium going into slag as sodium vanadate. Vanadium oxide or iron vanadate is a by-product of the extraction of radium from carnotite and is reduced in an electric furnace to ferrovanadium. Roscoelite-bearing sandstone is roasted with salt and pyrite, the product is lixiviated and filter-pressed, the filtrate is treated with a ferric salt to precipitate the vanadium as ferric vanadate, and the precipitate is filtered out and smelted in an electric furnace to ferrovanadium. Vanadium-bearing asphal-

tite has been burned in Peru and the ash shipped to the United States for further treatment. In smelting the minette ores the vanadium is carried off into the slag, from which it is later extracted.

PRINCIPAL DEPOSITS

South-West Africa.—Vanadium is mined at Abenab near Tsumeb, South-West Africa, as the mineral mottramite. The mines belong to the South West Africa Co., London, the Otavi Exploring Syndicate Ltd., London, and the Otavi Minen und Eisenbahngesellschaft, Berlin. Concentrates carrying 15 to 20 per cent V_2O_5 are shipped from Walfisch Bay to the Gesellschaft für Elektrometallurgie at Nürnberg, Germany, and to the ferrovanadium works at Lautawerk, Lausitz, owned jointly by the Otavi Minen und Eisenbahngesellschaft and the Vereinigte Aluminium-Werken.

Northern Rhodesia.—Vanadium is obtained in Northern Rhodesia as a by-product at the Broken Hill zinc deposit, where it is found in the zone of oxidation.

United States.—In general, vanadium occurs over a wide territory, but the deposits are all low-grade and rather small. The principal deposits of vanadium in the United States are to be found in Colorado, notably at Rifle and Naturite; vanadium also occurs in Utah and Arizona. The Colorado ores consist of roscoelite, a vanadium-bearing mica containing 1 to 2 per cent vanadium. In Colorado, carnotite ores, which are exploited for radium, contain vanadium as a by-product. These ores are the source of supply for the most of the vanadium produced in the United States.

Peru.—The principal vanadium deposits of the world are in Minasragra, Junin Department, Peru. The ore occurs here as patronite (V_2S_5 or VS_4) in lenticular masses in red clays. Secondary enrichment has altered the patronite of the upper horizons. The ores are concentrated at the mine to a product containing 11 to 12 per cent metallic vanadium and then shipped from Callao to the smelters in the United States. Under normal conditions Peru produces about two-thirds of the world output of vanadium, but owing to the shrinkage in market no shipments were made from 1930 to 1934. Recently shipments have been made, largely from accumulated stocks.

INDUSTRIAL USES

It might be said that the use of vanadium in our industrial world is a convenience but not a necessity. The estimate has been made that approximately 95 per cent of the vanadium produced throughout the world is utilized by the steel industries. For many years vanadium has been employed as a deoxidizing agent in the manufacture of steel. The present use is mainly as an alloying agent, usually in conjunction with nickel, manganese, molybdenum, or combinations of these metals. The function of vanadium in steel is to increase its strength, elastic limit, hardness, and shock. To obtain the same characteristics, steels made with vanadium do not require the amount of manipulation or labor that must be given to a steel in which vanadium is not used. Vanadium steels have the reputation of being foolproof. A small amount of vanadium is used annually as a catalyst in the manufacture of sulphuric acid and in making certain organic chemicals.

SUBSTITUTES

Vanadium is a high-priced metal which may be replaced with cheaper metals in many of its alloys.

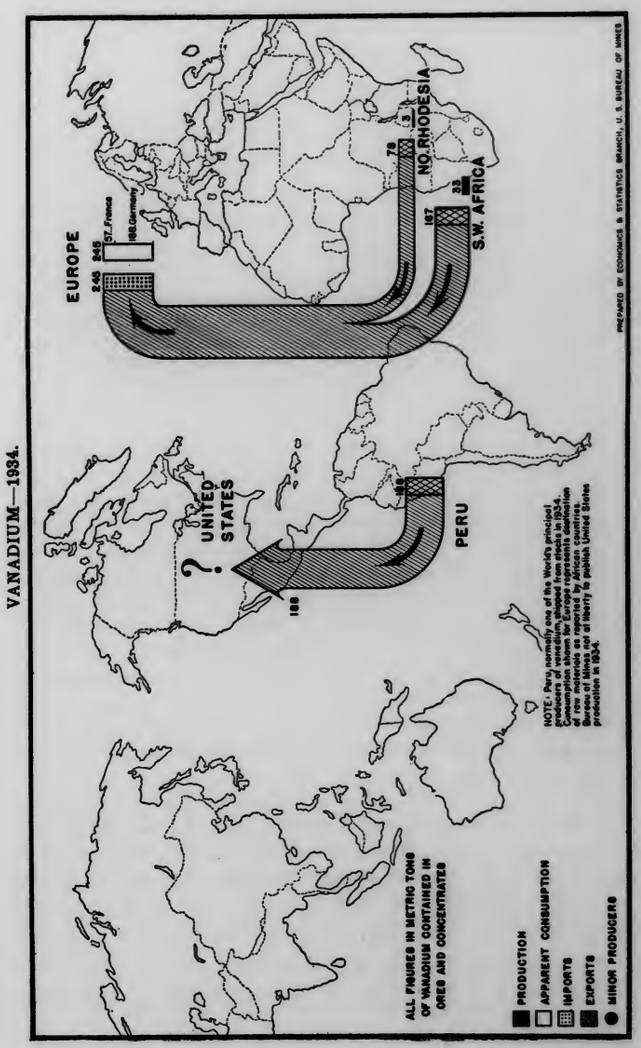
Reference

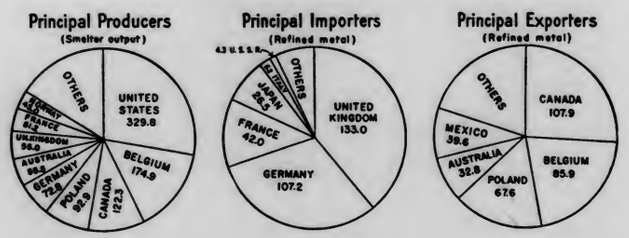
HESS, F. L.: Vanadium, *U. S. Bur. Mines, Inf. Circ.* 6572, 1932, 8 pp.

WORLD PRODUCTION OF METALLIC VANADIUM, 1932–1934
(In Metric Tons)

Country	1932	1933	1934
Northern Rhodesia	307	36	3
Peru	...	...	133[1]
South-West Africa	305	18	34
United States	245	2	9[2]
Total	857	56	179

[1] Shipments from stocks.
[2] Approximate production.





Zinc[1,2] and lead have dissimilar chemical and physical properties, yet they are associated in mineral deposits the world over. In some instances they occur separately; in others, they are combined with copper, silver, gold, cadmium, arsenic, and vanadium. Although there are many zinc minerals, the following are of commercial importance: sphalerite or zinc blende (ZnS), smithsonite ($ZnCO_3$), and calamine or hemimorphite $2ZnO.SiO_2.H_2O$). In the Franklin Furnace (N. J.) district, only zincite (ZnO), willemite (Zn_2SiO_4), and franklinite, $(FeZnMn)O.(FeMn)_2O_3$, occur as important ores of zinc. The gangue minerals associated with zinc deposits are the carbonates (calcite, siderite, rhodochrosite, and dolomite); barite; fluorite, quartz; chert; marcasite; and pyrite. The value of the ores may depend on the recoverable by-products.

Zinc deposits are of four types: (1) residual deposits, consisting chiefly of lead minerals with which the zinc is associated; (2) vein or fissure deposits, such as those of the upper Mississippi Valley; (3) replacement deposits located particularly in limestones and dolomites; and (4) disseminated deposits confined to limestones and dolomites, in which the mineral grains are scattered through

[1] Imperial Institute, London, Zinc, 2d ed., 1920–29, 1930, 193 pp.

[2] Pehrson, E. W., Summarized data of zinc production, *U. S. Bur. Mines, Econ. Pap.* 2, 1929, 47 pp.

the rock. Such deposits may contain considerable variety and complexity of minerals.

PRINCIPAL DEPOSITS

United States.—Since 1909 the United States has been the leading producer of zinc. The Central States—Arkansas, Kansas, Kentucky, Missouri, Oklahoma, and Wisconsin—are the largest producers of zinc ore. Production in the Western States of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, and Washington, during the period 1932–1934 fell below that of the Eastern States of New Jersey, Tennessee, and Virginia. Important new developments of deposits in northern New York and southwestern Virginia have been made in recent years.

Australia.—In Australia the Broken Hill district of New South Wales is the most important zinc producer in the British Empire, containing as it does the richest ores now known in the world. The early production was for lead and silver; the zinc ores were sorted out or left on the dumps. A company was organized later for the recovery of the zinc.[3]

In northern Queensland the large Mount Isa mine is a new development.

The principal zinc deposits in Tasmania are at Roseberry near the west coast.

Before the World War, by far the largest part of the zinc production of Australia was handled by German interests. The Broken Hill mines were under a long-time lease to a German company. With the outbreak of the war this lease was terminated, and on May 20, 1936, the Zinc Producers Association Proprietary, Ltd., of England was registered. The objective of this Company is to market the zinc ores, concentrates, and metals of Australia for 50 years.

Germany.—Before the World War the Zinkhüttenverband of Frankfurt-am-Main, Germany, aided by powerful financial and smelting interests, sought to control the nonferrous metal markets of the world, with special reference to zinc. This organization obtained, by long-term contract, zinc ores for smelting from all over the world. Australia was one of the principal sources of

[3] *Australasian Inst. Mining Met. Proc.* No. 87, Sept. 20, 1932, contains articles on mining, smelting, and geology at Broken Hill.

zinc concentrates. The World War broke this control, as the British Parliament passed in 1918 the "Nonferrous Metals Bill" to control the Empire supply of zinc concentrates and thus prevent, in the future, control by any other country of so essential a mineral commodity as zinc.

The zinc industry of Germany is divided into "Grubenhütten," or companies that smelt ores produced by their own mines, and the "Lohnhütten," or companies that smelt ores produced elsewhere and sold in the domestic markets. New plants have been constructed and old plants remodeled until the industry has been brought to high efficiency. Sulphuric acid plants are operated in conjunction with the smelters to use the sulphur generated by the roasting of the sulphide ores. The industry also has a number of zinc rolling mills. The German Government has aided the construction of new and modern zinc smelters. Recently a smelter has been built at Magdeburg, Saxony, to which the ores from German Upper Silesia will be sent. Other new zinc smelters are located at Oker, Brunswick, and Duisburg, Rhine Province. Zinc ores are also mined in western Germany at the Rammelsberg pyrite mine and in the Rhenish Schiefergebirge.

Canada.—The Canadian production comes from the Sullivan mine at Kimberley, British Columbia, a replacement deposit in shales and quartzites. The ores are smelted at Trail, British Columbia. There are potential zinc-producing deposits in the Noranda district, Quebec. These deposits have been inactive, owing to the low prices of zinc and copper that have prevailed since their development. The Flin Flon copper-pyrite deposit of Manitoba is the only other zinc producer operating in Canada at present.

Mexico.—Since selective flotation processes have come into use Mexico has become a large producer of zinc ore.[4] The principal producing districts are the Parral, Santa Eulalia, and Santa Bárbara in Chihuahua, Mapimi in Durango, Charcas in San Luis Potosí, and Fresnillo and Mazapil in Zacatecas. The deposits are of a variety of types, the Parral district (the most important) consisting of fissure veins. The ores, in general, are rather

[4] HAYWARD, M. W., and W. H. TRIPLETT, Occurrence of lead-zinc ores in dolomitic limestones in northern Mexico, *A.I.M.E., Tech. Pub.* 442, 1931, 31 pp.

impure. The greater part of the concentrates is sent to Europe for smelting.

Newfoundland.—The Buchans deposit of Newfoundland is a large producer of zinc ore. The ores are concentrated and exported for smelting.

Yugoslavia.—The chief producer of zinc ore in Yugoslavia is the Trepca mine in southern Serbia. Only a small part of the zinc concentrates is treated in Yugoslavia. The ores occur as complex sulphides replacing limestone.

Poland.—Poland, with its coal fields and zinc deposits in close proximity, is one of the largest producers of metallic zinc. The ore deposits are of the Mississippi Valley type; that is, replacements of dolomite. The zinc occurs in two fields, one of which extends from Beuthen in German Upper Silesia eastward into Poland beyond the town of Katowice. The ore contains 16 to 18 per cent zinc. The second field surrounds the Polish city of Tarnowitz, but the ores are too low grade to be profitably smelted. Prior to 1926, the enormous production was rapidly exhausting the sphalerite deposits of the field, and the calamine and smithsonite ores could not be smelted profitably. In that year (1926) the Germans developed the Waelz or revolving furnace, which reversed the situation by allowing more efficient and profitable smelting. Large amounts of these ores were known to exist both underground and on the mine dumps, chiefly in Germany. Since the World War, American capital has been invested in certain Polish properties after the partial withdrawal of German capital.

In accordance with the Versailles Treaty, the greater part of the zinc ore deposits and mines, the zinc oxide works, all of the smelters, the lead and silver plants, and most of the rolling mills in German Upper Silesia were acquired by Poland. The remnant of the zinc deposits in the redefined German Upper Silesia has subsequently undergone extensive and important development. Article 220 of the German-Polish agreement of May 15, 1922, provides that for 15 years raw or semimanufactured products originating in one part of the Upper Silesian industrial district may be sent to the other part for processing and shall be readmitted free of duty into the district of origination, even though a tariff should be assessed on zinc imported from other countries. The production of zinc and lead from the Polish mines has been

gradually decreasing, owing to the diminishing supply of sphalerite. The smelters in Poland depend on the constantly increasing production of the zinc ores of German Upper Silesia of which the Bleischarley mine near Beuthen is the chief source.

Italy.—Sardinia is the source of nearly two-thirds of the Italian zinc ore. On the mainland the Raibl mines of the Trieste region are the largest zinc producers.[5] Zinc is also produced in the Milan and Trentino regions. The industry is largely under foreign control. The character of the ore treated has gradually changed from calamine to sphalerite. Italy might now be considered self-sufficient as regards zinc, although some ores and spelter are imported for domestic consumption.

Spain.—The most important zinc deposits of Spain occur in the northwestern part in the Province of Santander, of which the Reocin district is the most important. Calamine deposits occur over a wide area replacing limestones. The concentrates are shipped to Rochefort, France, for roasting and sulphuric acid manufacture and reshipped to Norway for electrolytic refining. In the provinces of Murcia, Córdoba, and Lerida, zinc is produced from vein and replacement deposits.

British India.—The Bawdwin mines of Burma, in the Northern Shan States, are the largest zinc deposits of British India. Immense ore bodies are found along fault zones. The ore contains lead, silver, and nickel. These mines are under the British control of the Burma Corporation.

Sweden.—The most important zinc mine in Sweden is at Ammeberg; other deposits are found at Sala and Stollberg. Several ore fields have been discovered in northern Sweden by recent geophysical prospecting.

U.S.S.R. (Russia).—Production of zinc in the Union of Socialist Soviet Republics virtually ceased for a period after the World War. Zinc is now being mined in the Sadon district of the northern Caucasus region and also in the Ridder deposits of the Semipalatinsk region of the Altai Mountains. The Salair deposits, also in western Siberia, are now beginning to produce zinc ore. The Turlan deposits in the Karatau Mountains in southern Kazakstan are considered to be the largest zinc-lead deposits of the U.S.S.R. A zinc-lead smelter is under construc-

[5] RADCLIFFE, A. F., The Raibl mine, Cave di Predil, Italy, *Mining Mag.*, vol. 54, No. 2, February 1936, pp. 73–83.

tion at Chimkent in southern Kazakstan and according to Soviet sources will be the third largest zinc smelter in the world. Numerous deposits of zinc occur in the Karamazar Mountains southeast of Tashkent in central Asia. No production has commenced but this is a most important potential producing district. Doubtless the ore reserves of the U.S.S.R. are large, but the problem of transportation is a very serious one at present.

Japan.—The most important zinc district in Japan is the Toyama district. Some ore is imported from Australia. Chosen is a smaller producer of zinc ores.

Northern Rhodesia.—Large lenses of zinc ore occur at Broken Hill in Northern Rhodesia as replacement deposits of dolomite. Vanadium is produced as a by-product of the smelting operations.

Greece.—The zinc ores of Greece come from the large ancient mines at Laurium near Athens. These mines are now being worked by a French company.

Other Countries.—Zinc ores are also produced in Algeria, Belgium, Austria, Bolivia, Bulgaria, China, Czechoslovakia, Finland, France, Indo-China, Norway, Peru, Rumania, Turkey, and the United Kingdom.

METALLIC ZINC

Belgium, France, Norway, and the United Kingdom do not produce enough domestic ore to provide raw material for their output of metallic zinc. The Netherlands produces metallic zinc but no ore at all. This difference in output is accounted for by imports of concentrates and ores from other countries which lack fuel, skilled labor, and markets. The control of the zinc industry is based on the control of the reduction plants, ore buying, and metal-selling organizations rather than on ownership of deposits. The smelters, ore, and metal-trade organizations have been considerably decentralized since the World War.

INDUSTRIAL USES

Zinc is one of the most widely applied of the common metals, but the increase in its consumption is of comparatively recent development. The widespread use of zinc is little appreciated, owing to the fact that its greatest consuming uses are those in which it is alloyed with other metals. Zinc is the basis of the alloy *brass*, which alloy is indispensable to many industries. An

important part is played by zinc used as a coating for other materials, as it protects the metal against rust and corrosion. Millions of tons of galvanized material (zinc-coated metals) are produced annually in such forms as sheet, wire, pipes, and structural steel. The recent growth of the die-casting industries may be attributed largely to the utilization of zinc, not only because of its physical characteristics, but also because of its low price compared with other metals. The die-casting industry is making possible the low-cost production of metal parts of a great variety of shapes.

The largest consuming use of zinc is in the galvanizing industry, where sheets, tubes, wire cloth, and shapes are the major articles manufactured. Brass and castings are second in the consumption of zinc; and of less importance is the consumption for such uses as rolled zinc. The utilization of zinc as a pigment has in recent years grown rapidly. Lithopone, which is probably the most widely known of any of the white pigments, contains, as a rule, about 70 per cent barium sulphate and 30 per cent zinc sulphide.

SUBSTITUTES

Except in the manufacture of brass, other metals may be substituted for zinc, but as a rule these substitutes can only be made at a very material increase in cost.

References

INGALLS, W. R.: World survey of the zinc industry, New York, 1931, 128 pp.

JACKSON, C. F., KNAEBEL, J. B., and C. A. WRIGHT: Lead and zinc mining and milling in the United States; current practices and costs, *U. S. Bur. Mines, Bull.* 381, 1935, 204 pp.

WORLD MINE PRODUCTION OF ZINC, 1932–1934
(In Metric Tons)[1]

Country	1932	1933	1934
Algeria	1,860	2,300	2,400
Australia	117,529	125,688	138,955
Austria	1,611	2,103	2,582
Belgium[2]	3,000	3,000	3,000
Bolivia[3]	12,968	13,412	9,488
Bulgaria	.....	260	255
Canada	78,146	90,324	135,433
Chile	.....	4	.....
China	4,498	4,053	4,100
Chosen	.....	[4]	[4]
Czechoslovakia	1,618	1,358	1,270
Finland	875	1,084	1,078
France	1,215	1,000[2]	1,000[2]
Germany	75,275	104,363	131,731
Greece	6,715	11,958	12,000[2]
India, British[5]	23,345	33,425	37,468
Indo-China	5,000	4,989	4,959
Italy	32,183	29,139	45,971
Japan[2]	12,000	15,000	20,000
Mexico	57,256	89,339	125,186
Newfoundland	66,398	74,943	78,643
Northern Rhodesia	.....	18,839	19,854
Norway	8,874	9,251	6,394
Peru	212	204	5,551
Poland	21,602	37,460	48,434
Portugal	.....	.....	7
Rumania	4,000[2]	4,195	3,726
Spain	35,200	35,400	31,600
Sweden	24,544	24,737	29,121
Turkey	1,600	4,200	5,667
U.S.S.R. (Russia)	17,300	21,900	31,800
United Kingdom	4	4	452
United States[6]	258,756	348,611	398,003
Yugoslavia	47,965	59,262	53,817
Total	922,000	1,172,000	1,390,000

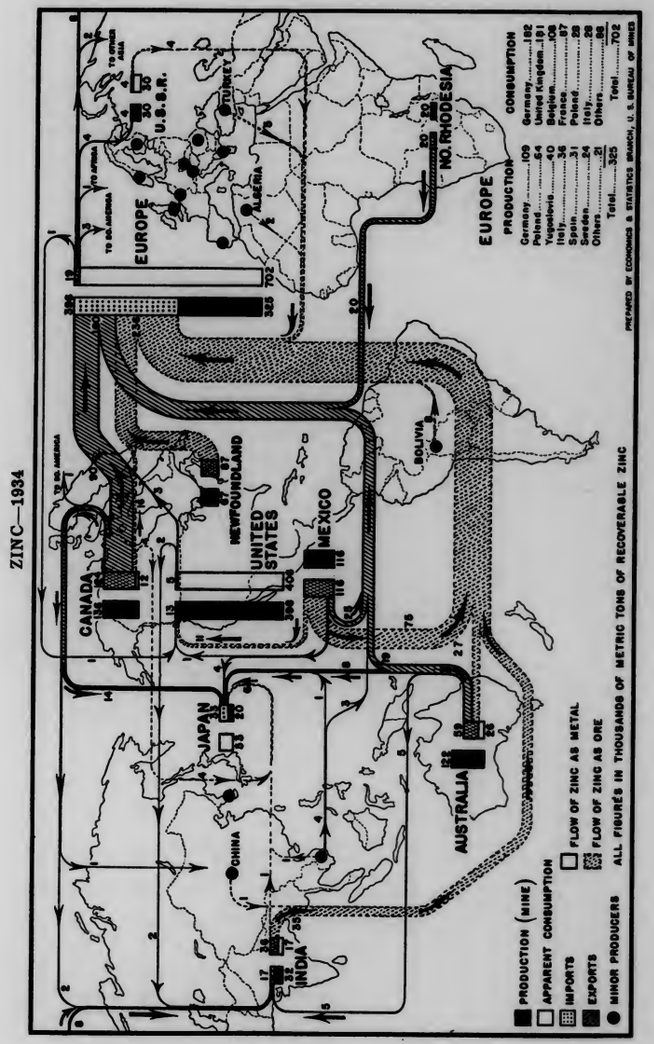
[1] Zinc content of ores produced, except as otherwise stated.
[2] Approximate production.
[3] Exports.
[4] Production of zinc ore reported as follows: 1933, 3,192 tons; 1934, 2,883 tons. No data available on zinc content.
[5] Estimated zinc content of zinc concentrates produced by the Burma Corporation, Ltd.
[6] Recoverable zinc content.

WORLD SMELTER PRODUCTION OF ZINC, 1932–1934
(In Metric Tons)

Country	1932	1933	1934
Australia	54,054	54,822	55,506
Belgium	96,330	137,300	174,900
Canada	78,146	83,412	122,394
Czechoslovakia	6,031	6,605	7,634
France	45,700	51,900	51,203
Germany[1]	41,979	50,867	72,888
Indo-China	2,280	3,250	4,960
Italy	17,984	23,283	24,864
Japan	27,043	30,658	29,637
Mexico	30,349	26,799	29,148
Netherlands	15,624	18,478	19,911
Northern Rhodesia	.....	18,839	19,854
Norway	39,373	44,948	45,027
Poland	84,953	82,866	92,921
Spain	9,505	8,548	8,184
U.S.S.R. (Russia)	14,800	16,900	26,300
United Kingdom[2]	27,300	46,000	55,000
United States	187,921	278,669	329,842
Yugoslavia	2,157	3,461	3,534
Total	782,000	988,000	1,174,000

[1] Exclusive of secondary material (Metallgesellschaft). The figures published by the Stat. Reichsamt, which include secondary material, are as follows: 1932, 45,035 tons; 1933, 61,000 tons; 1934, 71,196 tons.

[2] Some secondary material included (Imperial Institute, London).



RATIO OF TOTAL WORLD PRODUCTION IN 1934 TO PRODUCTION AND IMPORTS OF 12 MAJOR INDUSTRIAL COUNTRIES

Commodities	World production, metric tons	Percentage produced by 12 major industrial countries	Percentage imported by 12 major industrial countries
Aluminum	170,200	94.0	23.5
Antimony metal	21,400	3.5	72.4
Asbestos	279,000	80.0	76.7
Barite	666,000	98.8	17.5
Bauxite	1,315,000	67.5	59.5
China clay[1]	3,935,000	64.6	13.6
Chromite	619,000	25.3	66.1
Coal	1,275,000,000	86.3	5.8
Copper:[2] Unrefined	1,282,000	45.2	42.7
Refined	1,323,000	51.5	61.8
Fluorspar	242,000	93.7	10.2
Graphite	105,000	54.6	47.7
Gypsum[1]	7,800,000	88.8	8.7
Iron ore	122,700,000	86.7	23.4
Iron, pig	62,400,000	93.8	2.1
Lead:[2] Unrefined	1,337,000	49.4	19.2
Refined	1,317,000	60.8	47.5
Magnesite	1,232,000	49.9	22.6
Mercury	2,300	90.3	112.6
Manganese	2,861,000	67.2	62.3
Mica	25,500	54.7	32.3
Nickel[2]	71,600	84.7	144.3
Natural nitrates[4]			
Crude petroleum (bbl.)	1,522,230,000	71.6	8.7
Phosphate rock	9,416,000	39.6	49.3
Platinum	415,000	73.8	.....
Potash	2,175,000	96.5	72.7
Pyrites	6,968,000	89.8	35.1
Sulphur[5]	1,968,000	98.9	27.5
Talc and soapstone	544,500	55.1	24.4
Tin:[2] Unrefined	123,000	2.8	37.4
Metal	120,000	28.8	80.1
Tungsten	15,900	16.3	80.9
Vanadium[2]	179	5.0	187.7
Zinc:[2] Unrefined	1,390,000	60.0	66.7
Refined	1,177,000	79.8	29.9

[1] Estimated world production.
[2] In terms of metal.
[3] World production represents primary unmanufactured metal; trade statistics include manufactured products.
[4] Not susceptible of calculation, as trade statistics include synthetic or artificial with natural sodium nitrate.
[5] World production represents output of five principal producers only.

PART II

SURVEY BY COUNTRIES

FOREWORD

Beginning with 1933, world production of practically all industrial minerals increased progressively, and 1936 output, in many instances, surpassed the peak of 1929. International trade in mineral raw materials likewise increased. However, an unprecedented situation developed with respect to international trade in ores and primary metals during this period. National policies intended to stimulate domestic production in several major industrial nations, to minimize imports, and to increase exports of finished manufactured products have had the effect of diverting somewhat the flow of many essential mineral raw materials from primary to secondary sources of supply.

To what extent can the major industrial countries of the world, on the basis of their domestic resources, be considered self-sufficient in their supplies of mineral raw materials? In classifying industrial nations with respect to their domestic reserves of essential minerals, it is necessary to distinguish between those minerals which are of primary and secondary importance. Eight countries of the world (Belgium, France, Germany, Italy, Japan, Russia, United Kingdom, and United States), during the period 1933–1936, consumed in excess of 85 per cent of the principal industrial minerals. Collectively, these eight countries also produced a large percentage of world output of industrial minerals, but individually they are, and must continue to be, dependent on imports for certain minerals essential to the maintenance of their industries. Coal, iron ore, copper, and petroleum are absolutely essential to any nation with a highly developed industrial structure. While these four mineral raw materials may be considered of primary importance to any industrial nation, the relative importance of all mineral raw materials cannot be determined with any degree of accuracy.

The United States is best equipped in its supply of mineral raw materials. A few commodities such as tin, antimony, tungsten, etc., are not produced at all or in such limited quantities that for these products the country is dependent on imports. As a consumer of minerals, the United States ranks first among industrial nations, and as a producer, with the few exceptions cited, it is in a position second to none in its ability to provide its requirements from domestic sources.

The Soviet Union also is well supplied with mineral raw materials. However, it too is deficient in a few essentials such as tin, tungsten, sulphur, antimony, etc. Although the mineral wealth of the Soviet Union has not as yet been accurately determined, the more serious problem at the present time in its economic and industrial development is the inadequate supply of trained engineers, technicians, and workers experienced in the operation of modern equipment.

Coal represents the only mineral of primary importance of which the United Kingdom has an adequate supply. The British Empire, as a whole, is extremely well off in minerals but, from the angle of international trade, its Dominions must be considered as foreign sources of supply.

France, including its colonies, has an inadequate supply of minerals. From Domestic sources it has an exportable surplus of only iron ore and bauxite. During the period 1933–1935, 24 per cent of its apparent consumption of coal was imported; 98 per cent of its crude petroleum consumption was imported; and for such minerals as pig tin, manganese ore, and refined copper, its entire consumption of these raw materials during this period was imported.

To maintain its steel and allied industries, Germany can provide from within its own borders an adequate supply of coal only. During the period 1933–1935, 69 per cent of its apparent consumption of iron ore was imported; 100 per cent of manganese consumed was imported; 52 per cent of its apparent consumption of crude petroleum during the period was imported.

Belgium, Italy, and Japan, in the order mentioned, are probably more dependent than other industrial countries on imported mineral raw materials. Since 1933 Belgium has produced from 2 to 3 per cent of the annual world output of coal, but nevertheless it imported during the years 1933–1935, 17 per cent of its

apparent consumption; in the case of iron ore, Belgium produced slightly more than three per cent of the world output during the 3-year period mentioned and was required to import 76 per cent of its apparent consumption. Aside from these two primary industrial minerals, Belgium is entirely dependent on imports for its requirements of mineral raw materials.

Italy's resources of coal and iron are limited. During the period 1933–1935 it imported 93 per cent of its coal consumption and 34 per cent of its iron-ore consumption. However, in connection with what may be termed secondary minerals, Italy has an exportable surplus of mercury, of which it is the world's second most important producer, and of sulphur, of which, as a producer, it ranks next to the United States. It has what may be considered an adequate domestic supply of zinc.

The Japanese Empire is little better off than Italy in its domestic resources of minerals. Its copper reserves are probably greater than those of any other far eastern country but they are inadequate to meet industrial requirements. During the period 1933–1935, 38 per cent of Japan's apparent consumption of virgin copper was imported. Coal is the only primary industrial mineral of which Japan has ample reserves. Ninety-two per cent of its apparent consumption of crude petroleum during the period 1933–1935 was imported; 80 per cent of its pig-tin requirements was imported; 63 per cent of its manganese ore was imported although Japan in the last few years has produced from 2 to 3 per cent of this mineral so essential to its steel industry. Its reserves of iron ore are wholly inadequate to meet industrial demands. During the period 1933–1935, 79 per cent of its apparent consumption of iron ore was imported from countries other than Japanese possessions.

With respect to the mineral raw materials for which the major industrial nations of the world are entirely or partially dependent on imports, what sources of supply furnish essential requirements, and, in the last few years, what measures have been adopted by industrial nations to assure its nationals or industries an adequate supply of basic mineral raw materials? The accompanying tables covering imports by the principal industrial nations show the sources or countries of origin; in addition, a careful study of the tables will show, in many cases, material decreases in tonnage of certain commodities imported from former

supplying nations and increases in imports of the same commodity from other countries. The unequal distribution, by nature, of mineral raw materials, which necessitates imports of a few or many by the major industrial countries of the world, would present no serious problem were it not for obstacles of an artificial nature that restrict free access to logical sources of supply. These artificial barriers to free trade in essential mineral raw materials are of two types. The first consists of measures applied through government enactments which limit the purchasing power of a country's industrial consumers, and the second includes those restrictions, likewise the result of government action, which control and divert the international flow of mineral raw materials. Inadequate purchasing power of European continental industrial nations, principally Germany and Italy, has, since 1933, brought about conditions affecting procurement of essential minerals from the sources that for years have produced an exportable surplus. During the industrial recovery period since 1933, the forms of restriction affecting international trade are peculiar to this period. In international trade of today, insofar as it concerns minerals, ordinary tariffs play a relatively unimportant part. With reference to many commodities, import tariffs may restrict the volume and block circulation in international trade, but with respect to mineral raw materials where import duties are applied primarily to stimulate domestic production, the total world volume of trade remains practically unchanged. The monetary and quantitative measures of restriction, introduced and applied more and more vigorously in recent years, have like import tariffs influenced very little the total world volume of international trade in minerals, but they have materially altered or diverted the flow and channels of trade.

During the 3-year period 1933–1935, 84 per cent of Germany's consumption of virgin refined copper, amounting to 574,000 tons, was composed of imports. During that period domestic production ranged between 49 and 55,000 tons annually. In 1933 Germany imported 154,600 tons of refined copper of which 20,500 tons originated in the United States and in 1934 Germany imported 180,200 tons of refined copper of which 49,600 tons originated in the United States. However, in 1935, with a total of 153,300 tons of copper imported, Germany purchased only 16,500 tons from the United States, and during the first ten

months of 1936, out of 107,200 tons imported, only 5,900 tons were credited to the United States. This decrease in direct imports from the United States was made up largely by increases from South Africa and Yugoslavia.

Germany's aluminum industry is dependent on imports of bauxite. During the 3-year period 1933–1935, Germany's consumption of bauxite, amounting to approximately one million tons, enabled Germany to attain the position of world's largest producer of aluminum, although 98 per cent of the bauxite consumed was imported. During this period, Germany's imports of bauxite increased more than 280 per cent, or from slightly more than 200,000 tons in 1932 to 764,000 tons in the first 10 months of 1936. In 1929, France, the world's principal producer and exporter of bauxite, supplied Germany with practically 40 per cent of the tonnage imported while Yugoslavia furnished only about 17 per cent; during the first 10 months of 1936, imports of bauxite into Germany from France represented only slightly more than 10 per cent of total imports while Yugoslavia contributed 22 per cent and Hungary 32 per cent.

These shifts in sources of supply are attributed to national policies which differ from country to country and from time to time in the same country, and there are intricate connections between governmental monetary and trading policies that influence international trade. In analyzing the causes of trends in trade during the past 3 years, it is necessary to consider as closely related subjects the problems of exchange control, import quotas, export restrictions, export premiums or subsidies, so-called excise taxes, compensation agreements, and clearing and paying agreements, which, considered collectively, have become an integral part of present-day national policies of several countries.

During 1936 the world was confronted with two conflicting methods of conducting international trade. The first is promotion of foreign trade with tariffs only as regulatory measures restricting such trade and with the initiative left to individuals for the promotion and development of trade. The reciprocal-trade-agreement program of the United States and the agreements with 14 countries concluded under it and in effect in December 1936 represent effort made in this direction. In the opposite direction there has been a decided tendency on the part of many countries to adopt bargaining measures centralized in the

national government, such as (1) exchange regulations; (2) import quotas that tend to restrict or abolish trade with certain countries; (3) export subsidies that facilitate the sale of commodities in world markets and thus enable the exporting country to acquire in some degree essential raw materials; and (4) clearing and compensation agreements that enable the central government to control more or less the countries with which its nationals trade.

PRODUCTION IN BELGIUM OF 32 MAJOR INDUSTRIAL MINERALS
(In Metric Tons)

Commodities	1932	1933	1934	Per cent of total world[1]
Metals:				
Aluminum				
Antimony			100	
Bauxite				
Chromite				
Copper[2]				
Iron ore	92,810	106,200	115,890	
Pig iron and ferro alloys	2,748,740	2,710,430	2,952,520	4.7
Lead[2]				
Manganese				
Mercury				
Nickel				
Platinum (troy oz.)				
Tin[2]				
Tungsten				
Vanadium				
Zinc[2]	3,000	3,000	3,000	
Nonmetals:				
Asbestos				
Barite				
China clay[4]	9,720	13,870	14,520	
Coal	21,424,000	25,300,000	26,389,000	2.0
Fluorspar				
Graphite				
Gypsum				
Magnesite				
Mica				
Natural Nitrates				
Petroleum, crude (bbl.)				
Phosphate rock	25,810	25,130	14,385	
Potash: Equivalent K_2O				
Pyrites	[5]	[5]	[5]	
Sulphur				
Talc and soapstone				

[1] Calculated on basis of 1934 production; items representing less than one-half of 1 per cent not calculated.
[2] Mine production in terms of metal content.
[3] Approximate production of ore in terms of metal content.
[4] "Eurite" and kaolin.
[5] Production reported, but figures not shown separately.

BELGIUM[1]

Belgium is in a position somewhat similar to that of Japan and Great Britain in that its area of only 11,754 sq. mi. (including Luxemburg) contains relatively few domestic sources of supply of major industrial minerals. Nevertheless, it is an outstanding importer and consumer of the essential raw materials required for the maintenance and development of its manufacturing industries that produce not only for home consumption but compete in the leading markets of the world. On a much smaller scale Belgium, like Great Britain, controls vast resources of certain essential minerals, particularly copper, tin, and radium, through its colonial possessions, particularly Belgian Congo. Radium, because of its specialized use, is not considered in this study. Belgium depends on imports for all of the major industrial minerals, except coal, required to maintain its iron and steel industry, as well as for those nonferrous metals necessary for the development of its fabricating plants. The accompanying table of imports clearly illustrates the dependence of Belgium on foreign sources of supply for essential mineral raw materials, particularly copper ingots, iron ore, lead and zinc ores, manganese, and mercury. The reserves of those commodities that are produced to some extent in Belgium, such as phosphate rock, are inadequate to meet domestic requirements, and imports are essential. It will be noted that, with respect to all of the essential raw materials, there was a decided increase in importations during the 3-year period 1932–1934.

The Belgian Bureau of Mines of the Ministry of Labor was organized to assist and, to some extent, regulate the mining industry. The bureau is responsible for inspection of mines; evaluation of, and taxation on, mining properties; concessions; the collection and publication of mineral statistics and pertinent economic information; geologic investigations; and the preparation for publication of such reports, maps, etc., relative to these subjects, as may be considered necessary. The Central Statis-

[1] Almanach Royal Official, Brussels, 1935, p. 1266.

tical Board functions under the Minister of the Interior and is responsible for the publication of the "Statistical Annual of Belgium and of the Belgian Congo," which includes general mining statistical information. To assist the national Bureau of Mines, the Council of Mines was organized to serve more or less in an advisory capacity, with particular reference to matters of legislation and services of other departments that may have a direct bearing upon one or another phase of the mining industry.

IMPORT TRADE OF BELGIUM-LUXEMBURG BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934[1]

Classified group	1932	1934
Metals		
Aluminum (metric tons)		
Bauxite (ore)	1,611	1,042
Hydrated alumina	6,132	7,462
Crude, in lumps, ingots, waste, scrap of old manufactures	831	1,298
Sheets, leaves, slabs, or plates	98	342
Foil	96	163
Bars or wires	110	143
Tubes and pipes	8	18
Sulphates	294	1,075
Oxide (anhydrous alumina)	8	56
Antimony (metric tons)		
Ore	2,217	2,004
Metallic antimony, regulus	387	563
Copper (metric tons)		
Ore	56,992	5,653
Crude cast copper, in ingots, lumps, etc. and waste and scrap	38,549	114,612
Sheets, leaves, or plates	421	240
Bars and wires, simply rolled or drawn	684	827
Tubes and pipes, simply drawn or welded, etc.	295	329
Cables and cordages of copper wire, not insulated	13	10
Iron ore (metric tons)	9,482,410	10,260,589
Pig iron (metric tons)	155,938	150,505
Ferroalloys (metric tons)		
Ferrometallic alloys	53,649	64,376
Old scrap, cast and steel	132,855	142,317
Lead (metric tons)		
Ore (galena, cerusite, etc.)	42,811	97,465
Pig and scrap	26,384	20,198
Foil, simply rolled	16	8
Bars, rods, rolled or drawn wire, etc.	34	19
Pipes, tubes, and joints	26	7
Manganese ore (metric tons)	154,738	205,947
Mercury, Quicksilver (kilograms)	71,300	77,500
Nickel (metric tons)		
Crude ingots or cast slabs, anodes and scrap	5,788	3,124
Sheets, leaves, slabs, or plates, hammered or rolled, etc.	53	77
Bars and wire, simply rolled or drawn	36	59
Pipes and tubes, simply drawn and welded, etc.	2	4
Platinum unworked, in lumps, ingots, cast bars, or powder (thousand francs)	2,221	5,952
Tin (metric tons)		
Ore	1,179	5,769
Crude, in lumps, pigs, granules, and scrap	3,683	2,213
Sheets, leaves, and plates, simply rolled	20	50
Foil, simply rolled, etc.	2	11
Bars and wires, rolled and drawn	12	17
Zinc (metric tons)		
Ore	255,637	435,240
Crude, in lumps, pigs, or cast slabs, and scrap	25,873	17,399
Pipes, tubes, and joints simply drawn or welded, etc.	15	16
Sheets, leaves, slabs, or plates	1,358	460

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

IMPORT TRADE OF BELGIUM-LUXEMBURG BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934.[1]—(*Continued*)

Classified group	1932	1934
Cast, stamped, or forged pieces, rough	3	9
Powders and dust	97	13
Lithopone (including sulphide of zinc and Griffith's White)	778	560
Nonmetals		
Asbestos (metric tons)		
Unmanufactured	5,468	10,797
Paper and board	55	74
Barium minerals (metric tons)		
Chloride	42	942
Dioxide	22	8
Sulphate	1,252	909
Sulphide	13	88
China clay (metric tons)	36,123	47,209
Coal (metric tons)		
Pit (including anthracite)	6,734,204	4,483,405
Briquets, boulets, etc	201,916	189,827
Lignite	167,558	129,241
Coke	1,942,504	2,337,720
Fluorspar (metric tons)	1,812	2,349
Graphite, crude and ground (metric tons)	1,082	862
Gypsum (metric tons)		
Crude	91,674	114,871
Ground and calcined	35,802	40,028
Alabaster, crude	7	19
Magnesite, calcined (metric tons)	896	923
Mica (metric tons)		
Crude, in sheets, plates, or rough disks	102	132
Cut sheet and plate	11	16
Nitrate of soda (unpurified) (metric tons)	15,160	96,334
Petroleum (barrels)		
Crude	172,000	1,641,000
Gasoline	2,798,000	2,294,000
Kerosene	670,000	213,000
Lubricating oil	441,000	443,000
Fuel oil	753,000	289,000
Gas oil	.....	23,000
Grease (pounds)	2,900,000	2,820,000
Paraffin (pounds)	11,172,000	16,221,000
Petrolatum (pounds)	2,028,000	(Not avail.)
Ozokerite, crude (pounds)	.....	536,000
Ozokerite, refined (ceresin) (pounds)	.....	285,000
Petroleum pitch and other residues (metric tons)	5,604	(Not avail.)
Petroleum residues and asphalt (metric tons)	(Not avail.)	13,794
Rock asphalt (metric tons)	1,547	956
Asphalt and bitumen (metric tons)	7,109	8,810
Phosphates (metric tons)		
Phosphate rock	251,395	339,266
Superphosphates	17,439	17,768
Basic slag	73,858	155,111
Potash salts (metric tons)		
Kainite, carnallite, etc	196,633	345,810
Caustic (crystallised or refined)	59	117
Caustic lyes	11,396	2,150
Carbonate (crude)	768	529
Carbonate, refined	603	465
Chlorate	709	680
Chromates (including those of sodium)	479	696
Manganate and permanganate	101	98
Nitrate, refined	671	1,144
Nitrate	1,268	6
Chloride	92,663	263,991
Sulphate	6,854	1,971
Other potash salts (n.e.s.)	62	595
Sulphur (metric tons)	9,052	11,904
Talc (metric tons)	3,058	3,107

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

PRODUCTION IN CANADA OF 32 MAJOR INDUSTRIAL MINERALS
(In Metric Tons)

Commodities	1932	1933	1934	Per cent of total world[1]
Metals:				
Aluminum	17,800	16,200	15,800	9.2
Antimony	.....	.....	.....	
Bauxite	.....	.....	.....	
Chromite[2]	71	27	101	
Copper[3]	112,345	136,069	165,452	12.9
Iron ore	.....	.....	.....	
Pig iron	162,179	261,582	441,916	
Lead[3]	116,095	120,870	157,067	11.7
Manganese	.....	.....	.....	
Mercury	.....	.....	.....	
Nickel[3]	13,756	37,768	58,371	81.5
Platinum (troy oz.):				
Placer platinum	59	40	53	
From refineries:[4]				
Platinum	27,284	24,746	116,177	[11]
Other platinum metals	37,593	31,009	83,932	[11]
Tin	.....	.....	.....	
Tungsten	.....	.....	.....	
Vanadium	.....	.....	.....	
Zinc[3]	78,146	90,324	135,433	9.7
Nonmetals:				
Asbestos[5]	111,562	143,667	141,502	[11]
Barite	.....	18	.....	
China clay	.....	.....	44	
Coal: Anthracite and bituminous	7,507,000	8,533,000	9,613,000	
Lignite	3,142,000	3,370,000	2,916,000	
Fluorspar	29	66	136	
Graphite	314	367	1,377	[11]
Gypsum	398,883	336,283	457,511	5.8
Magnesite[6]	2,833	27,158	[7]	
Mica[8]	280	857	905	
Natural Nitrates	.....	.....	.....	
Petroleum, crude (bbl.)	1,044,000	1,145,000	1,417,000	
Phosphate	1,194	2,008	73	
Potash: Equivalent K_2O	.....	.....	.....	
Pyrites	47,210	53,164	10,040	
Sulphur	[9]	[9]	[9]	
Talc and soapstone[10]	10,980	13,772	12,663	[11]

[1] Calculated on basis of 1934 production; items representing less than 0.5 of 1 per cent not calculated.
[2] Shipments.
[3] Mine production in terms of metal content.
[4] Recovered from nickel-copper mattes.
[5] Exclusive of sand and gravel, production of which is reported as follows: 1932, 3,151 tons; 1933, 5,850 tons; 1934, 4,238 tons.
[6] Magnesitic dolomite.
[7] Data not available.
[8] Sales.
[9] Estimated sulphur content of gas used in acid making reported as follows: 1932, 24,690 tons; 1933, 26,485 tons; 1934, data not shown separately.
[10] Excluding soapstone, which is reported only by value and was as follows: 1932, $46,751; 1933 $47,680; 1934, $44,297. Soapstone is sold in the form of both blocks and powder.
[11] Not susceptible of calculation.

CANADA

Pursuant to the Department of Mines and Resources Act, 1936, the Canadian Government announced formation, as of Dec. 1, 1936, of the Department of Mines and Resources. The new department represents a merger of the former Departments of Interior, Mines, Immigration and Colonization, and Indian Affairs. Under the new department the following five branches will operate as bureaus: Mines and Geology; Lands, Parks, and Forests; Indian Affairs; Surveys and Engineering; and Immigration.

The Mines Branch will be responsible for conducting Dominion-wide explorations and will prepare and publish, for general dissemination, reports relative to natural resources. It will also maintain testing laboratories.

Statistics of Mines and Minerals.[1]—The compilation and publication of statistics concerning mines and minerals in the Dominion is carried out by the Mining, Metallurgical, and Chemical Branch of the Dominion Bureau of Statistics, Department of Trade and Commerce, which works in close cooperation with the mines departments of the various provincial governments, collecting the data in collaboration with these departments. Questionnaires sent to those engaged in mineral industries are designed to meet the requirements of both the Dominion and the provincial authorities, thus eliminating duplication of labor.

Detailed information on the mineral production of Canada is published in the various reports issued by the Mining, Metallurgical, and Chemical Branch of the Dominion Bureau of Statistics. The more important of these are: Annual preliminary reports on the mineral production of Canada; a complete, detailed, annual report on the mineral industries; monthly bulletins on the production of the 16 leading minerals; and monthly, quarterly and annual reports on coal statistics.

Mineral Lands Administration.—The mineral lands of Canada, like other Crown lands, are administered by either the Dominion or the provincial government. The Dominion Government administers the mineral lands of Yukon and the Northwest Ter-

[1] Abstracted verbatim from "The Canada Yearbook, 1936," Dominion Bureau of Statistics, pp. 335–355.

ritories as well as those in all Indian Reserves and in National Parks in the Prairie Provinces and British Columbia. All other mineral lands lying within the boundaries of the several provinces are being administered by the respective provincial governments.

Summary of General Production.—Since 1886, the first year in which the Geological Survey issued complete returns of mineral production, Canada has made a fairly steady growth in mineral output. In that year the per capita production was only $2.23; in 1901, 5 years after the Yukon discoveries, production totaled $12.16 per capita, but there was a decrease from 1902 to 1904. Thereafter, owing to the discovery of silver in the Cobalt area, the development of the copper-nickel ores of the Sudbury district, the opening up of the gold mines of Porcupine and Kirkland Lake in Ontario, the improvements in metallurgical practice that led to the recoveries of large quantities of lead and zinc from British Columbian ores, and the discoveries and developments in Quebec and Manitoba, the per capita production rose to $31 in 1929, although, owing to world-wide economic depression, it dropped to $18.20 in 1932, it rose again to $25.67 in 1934 and about $28.33 in 1935, with the mineral industry leading in the general improvement in economic conditions.

In 1934, the latest year for which comprehensive world figures are available, Canada ranked first in the production of asbestos, nickel, and the platinum metals; second in zinc and radium; third in copper, gold, silver, and cobalt; fourth in lead; and tenth in coal. During that year (see accompanying table), Canada produced approximately 81 per cent of the world production of nickel, 69 per cent of the asbestos, 13 per cent of the copper, 12 per cent of the lead, and 10 per cent of the zinc.

The Preliminary Report on the mineral production of Canada, based on a special survey of the industry by the Dominion Bureau of Statistics and released on Mar. 10, 1936, shows a total valuation of $310,162,455 for the mineral output of the Dominion in 1935 compared with $278,161,590 in 1934. This represents an increase of 11.5 per cent and reflects continuation of the improved conditions commencing in 1933.

Prospecting for gold ores and the exploration and development of known auriferous deposits were carried on more extensively throughout Canada during the recent period 1932–1935 than ever before. These activities were common to both the older producing camps and new areas. The higher price for gold stimulated the study and examination of new deposits or ore zones heretofore considered of doubtful economic importance. In certain older camps properties closed prior to the revaluation of gold were reopened and placed in production or explored further as to their possibilities. In some of the producing mines the higher price for the metal permitted a very considerable extension or increase of pay ore, with the resultant milling of rock of lower gold content and important increases in ore reserves. During 1934, notable gains in production compared with 1933 were recorded in the base-metal mining industry, and these gains were extended during 1935. The more outstanding of these were in copper, lead, nickel, and zinc.

Production of various nonmetallic minerals, especially asbestos and coal, has made important gains since 1932. The gains in the structural-materials industries are worthy of note during 1934 and 1935, as recessions had been severe during the period of business depression.

Provincial Distribution of Mineral Production.—The principal mineral-producing province of Canada in recent years has been Ontario, which produced 52.3 per cent of the total Dominion mineral output in 1934. The rise in the price of gold has been especially favorable to Ontario's mineral production, while the Sudbury nickel-copper deposits are another outstanding feature in the mineral resources of the province. British Columbia holds second place in the value of minerals produced, with 14.8 per cent of the Dominion totals in 1934. The mineral resources of British Columbia are probably more varied than those of any other province, since its production includes most of the important metals as well as substantial quantities of coal. Mineral production in Quebec has increased greatly in the postwar period, accounting for 11.2 per cent of the total for Canada in 1934. Whereas formerly nonmetallics (especially asbestos) and structural materials made up nearly all of its mineral production, more than half the value is now made up of metals, particularly gold and copper. Nova Scotia and Alberta are the most important coal-producing provinces. In recent years Manitoba has been making a growing contribution to the production of gold, copper, and zinc in the Dominion.

Developments since 1929.—Since 1929 the mining industry in Canada has been affected by the world-wide economic dis-

turbances, accompanied by a very drastic decline in the prices of most of the principal metals, especially copper, lead, zinc, and silver. However, since 1931 the price of gold, on the other hand, has risen to a level about 69 per cent above that formerly prevailing. Under the influence of the early decline in base-metal prices, the value of the net production of the metallic mineral industries declined by 27 per cent from 1929 to 1932, with a decline of 29 per cent in number of employees and 30 per cent in salaries and wages paid. But, since the higher price for gold stimulated its production and the readjustment of costs stabilized the base-metal industries, metal production has expanded again, the net sales in 1934 being 14.6 per cent above those of 1929, employees 9.7 per cent above, and salaries and wages 1.0 per cent above 1929. Industrial statistics for 1935 are not yet available, but the production figures for that year indicate a continued rapid growth in metal production. Doubtless, in reaching this new record, the influence of gold is important through increased production, higher value, and its association with other metals, especially copper. However, in 1934 and 1935 not only gold but nickel, copper, lead, and zinc were produced in Canada in larger quantities than ever before, from which it must be concluded that the producers of these metals can operate profitably, even at the low prices prevailing for copper, lead, and zinc.

Among the nonmetallic industries, the demand for coal declined, owing to reduced requirements in industrial and transportation activities. Similarly, the demand for asbestos and gypsum was affected by the lower level of industrial and construction operations. Salt was an exception to the general rule, as its production was well maintained throughout, owing partly to its increased consumption in certain chemical industries. Indeed, the net sales of the salt-producing industry increased each year from 1929 to 1932 to a level about 23 per cent above that of 1929. Taking the group of nonmetallic industries as a whole, net sales declined 32 per cent from 1929 to 1932, employment 21 per cent, and salaries and wages 36 per cent. Net sales in 1934 increased 11.4 per cent from the low point of 1932, and there was a change to an upward trend in employment also in 1934.

The production of clay products and other structural materials is directly dependent upon construction activities within Canada. During the early years of the depression, these activities were

partly maintained by government relief projects and by carrying to completion some large operations that had been started before 1930. As a result, construction reached its lowest level in Canada during 1933, and the group of industries producing clay products and other structural materials was at a lower level of operations in that year than in any other year recorded since 1921. From 1929 to 1933 there was a decline of 71 per cent in net sales, 69 per cent in employees, 74 per cent in salaries and wages, and 76 per cent in expenditures for fuel and electricity, a large item in the cost of production in these industries. However, construction was more active in Canada in 1934 than in 1933, and this increased activity was accompanied by a welcome change to a rising trend in the production of clay products and other structural materials.

It is interesting to note the uneven influence of the economic disturbances of recent years upon different divisions of the mineral industry. Production in Canada reached its highest recorded value—$310,850,000—in 1929. The production of metallic minerals actually expanded farther in volume in 1930, but the rapid decline in prices characteristic of the period checked this growth, so that in 1932 the production of metallic minerals was only 3.7 per cent greater in volume than in 1929, while drastic declines had occurred in the volume of production in other divisions, fuels being reduced 28.9 per cent, other nonmetallics 47.8 per cent, clay products 72.1 per cent, and other structural materials 57.6 per cent. The rapid decline in prices was arrested by 1933, and in that year there was increased volume of production in both metallic and nonmetallic minerals, although there were further declines in structural materials. In 1934 the improvement made itself felt in all divisions of the industry, although production was still on a much smaller scale than in 1929 in all divisions except metals. Compared with 1929 the volume of production in 1934 was 29.6 per cent greater for metallic minerals, 19.6 per cent smaller for fuels, 36.9 per cent smaller for other nonmetallics, 77.5 per cent smaller for clay products, 60.7 per cent smaller for other structural materials, and 4.8 per cent smaller for the whole mineral industry. Preliminary figures for 1935 indicate a further considerable growth in the production of metals and of nonmetallic minerals other than fuels, while fuels and structural materials maintained the gains of the preceding year.

IMPORT TRADE OF CANADA BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934[1]

Classified group	1932	1934
Metals		
Aluminum (metric tons)		
Bauxite	46,854	74,347
Alumina	31	48
Pigs, ingots, blocks, bars, slabs, billets, and blooms	94	36
Pipes and tubes	27	37
Bars, rods, and wire	36	112
Plates, sheets, and strips, including circles	570	553
Scrap	22	160
Antimony, (regulus (metric tons)	286	284
Copper (metric tons)		
Precipitate of, crude	9	
Blocks, pigs, or ingots	120	16
Bars or rods	212	215
Bars or rods in lengths of not less than 6 ft., unmanufactured, n.o.p.	77	110
Wire, n.o.p.	20	33
Strips, sheets, or plates, not polished or coated	130	101
Tubing, in lengths of not less than 6 ft. not polished or bent, and manufactured wire	515	149
Scrap cathode plates of electrolytic copper for melting	4	12
Subacetate of, or verdigris, dry	1	1
Iron ore (metric tons)	61,295	886,624
Pig iron (metric tons)	4,829	6,522
Ferroalloys (metric tons)		
Ferromanganese, phosphorus, silicon, spiegeleisen, and other crude ferro-alloys	289	1,246
Scrap and cast scrap iron	16,557	6,426
Wrought scrap	38,524	47,051
Lead (metric tons)		
Pig and block	13	44
Bars and sheets	72	27
Pipes	14	3
Shots and bullets	3	6
Old and scrap	.....	3
Compounds of tetraethyl lead (tetraethyl lead is the preponderant constituent by weight)	692	826
Nitrate, not ground	73	110
Arsenate	377	204
Manganese, oxide of (metric tons)	1,372	28,080
Mercury, Quicksilver and cinnabar (kilograms)	19,612	111,988
Nickel, nickel silver and silver chromium in ingots, blocks, bars, rods, strips, sheets, plates, anodes, etc. (metric tons)	244	313
Tin (metric tons)		
Blocks, pigs, or bars	1,428	1,814
Foil	3	16
Tin-strip waste and tin-plate scrap	855	647
Bichloride of, and crystals	538	151
Tungsten, chromium and tungsten metal in lumps, powder, ingots, blocks or bars, and scrap (metric tons)	7	12
Zinc (metric tons)		
Dust	2	5
Strips, sheets, and plates for boilers	18	18
Blocks, pigs, bars, rods, and plates	1	
Lithopone	7,308	6,591

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

IMPORT TRADE OF CANADA BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934.[1]—(*Continued*)

Classified group	1932	1934
Nonmetals		
Asbestos, packing (metric tons)	50	76
arium minerals (metric tons)		
Barites	1,172	1,412
Blanc fixe	423	439
Peroxide	2	3
Satin white	276	298
China clay (metric tons)	15,706	29,710
Coal (metric tons)		
Anthracite	2,856,621	3,175,642
Bituminous and coal n.o.p.	7,728,463	8,337,043
Lignite	2,725	2,532
Coke	554,274	734,409
Petroleum, ground and other	33,650	67,934
Fluorspar (metric tons)	916	6,550
Gypsum (metric tons)		
Plaster of paris or calcined gypsum, and prepared wall-plaster	1,256	499
Plaster of paris, ground, not calcined	155	157
Crude, sulphate of lime	50	18
Magnesite (metric tons)		
Magnesium carbonate, basic or otherwise, except crude rock	359	424
Dead-burned, sintered, caustic, calcined, or plastic magnesia	966	428
Nitrate of soda (metric tons	16,814	23,605
Petroleum (barrels)		
Crude, in its natural state, 0.790 sp. gr. or heavier	25,424,000	30,638,000
Crude, not in its natural state, 0.725 sp. gr. or heavier	573,000	51,000
Petroleum and other oils for concentration of ores	3,000	2,000
Fuel oil	1,637,000	942,000
Bunkers, fuel oil, ex-warehoused for ships' stores	914,000	671,000
Gasoline	2,902,000	1,759,000
Lubricating oil	331,000	300,000
Kerosene	50,000	60,000
Other petroleum oils	7,000	17,000
Naphtha and other petroleum products, n.e.s.	53,000	53,000
Asphalt, not solid	(Not avail.)	3,000
Asphalt, solid (metric tons)	(Not avail.)	4,550
Axle grease (pounds)	3,149,000	3,375,000
Paraffin wax (pounds)	1,620,000	6,064,000
Phosphates (metric tons)		
Phosphate rock	64,802	28,825
Superphosphates	55,065	71,927
Blast furnace slag, basic slag, crushed or ground	6,954	3,080
Potash salts (metric tons)		
Kainite, and German potash salts	3,948	2,647
Muriate of potash, crude	13,301	20,628
Nitrate of, or saltpetre	336	929
Sulphate of, crude	1,220	1,540
Other potash compounds	1,380	1,254
Sulphur and brimstone, crude, in rolls, or flowers of (metric tons)	95,249	143,060
Talc or soapstone, ground or unground (metric tons)	1,724	2,628

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

PRODUCTION IN FRANCE OF 32 MAJOR INDUSTRIAL MINERALS
(In Metric Tons)

Commodities	1932	1933	1934	Per cent of total world[1]
Metals:				
Aluminum	14,400	14,500	16,300	9.5
Antimony[2]	510	312	202	
Bauxite	401,430	490,500	528,400	40.1
Chromite	.....	.....	.....	
Copper[3]	435	226	[4]	
Iron ore	27,599,320	30,245,000	32,015,000	26.5
Pig iron and ferroalloys	5,537,460	6,359,000	6,155,000	9.8
Lead[3]	3,220	1,250	2,000[5]	
Manganese	.....	.....	.....	
Mercury	.....	.....	.....	
Nickel	.....	.....	.....	
Platinum (troy oz.)	.....	.....	.....	
Tin[3]	.....	.....	.....	
Tungsten[6]	.....	.....	.....	
Vanadium	.....	.....	.....	
Zinc[3]	1,215	1,000[5]	1,000[5]	
Nonmetals:				
Asbestos	300	[4]	[4]	
Barite	10,400	[4]	[4]	
China clay	100,400	[4]	[4]	
Coal: Anthracite and bituminous	46,267,000	46,887,000	47,607,000	3.8
Lignite	1,012,000	1,093,000	1,031,000	
Fluorspar	15,200	[4]	[4]	
Graphite	.....	.....	.....	
Gypsum	2,081,010	[4]	[4]	
Magnesite	.....	.....	.....	
Mica	.....	.....	.....	
Natural nitrates	.....	.....	.....	
Petroleum, crude (bbl.)	530,000	562,000	557,000	
Phosphate rock	82,700	71,124	79,252	[9]
Potash[7]: Equivalent K_2O	326,500	332,000	378,900	17.4
Pyrites	191,600	168,422	155,113	[9]
Sulphur	820[8]	[4]	[4]	
Talc and soapstone	68,500	[4]	[4]	

[1] Calculated on basis of 1934 production; items representing less than one-half of 1 per cent not calculated.
[2] Recoverable metal content of ore produced (80 per cent of reported content), exclusive of antimonial lead ores.
[3] Mine production in terms of metal content.
[4] Data not available.
[5] Approximate production.
[6] Concentrates containing 60 per cent WO_3.
[7] Content of marketable products.
[8] Sulphur rock.
[9] Not susceptible of calculation.

FRANCE[1]

Within its borders France possesses adequate resources of iron ore, bauxite, and potash; as indicated in the accompanying production table, that country is the world's leading producer of the first two commodities and is surpassed only by Germany in the output of potash. Moreover, French Colonial possessions of Northern Africa furnish practically all of her phosphate requirements, and New Caledonia, a French possession, normally supplies 15 to 20 per cent of the chrome-ore imports as well as practically all of the nickel required by industry. Although France has sufficient iron ore, its reserves of coal are inadequate to meet the requirements of its iron and steel industry; in consequence, approximately one-third of the domestic output is imported annually, principally from the United Kingdom, Belgium, and Germany. For its steel industry France also depends on imports of manganese ore. In 1934, French imports of manganese ore represented approximately one-fifth of the total world production, and the principal sources of supply were Russia and Gold Coast. With reference to nonferrous metals, France is notably deficient in domestic reserves and, in consequence, relies on imports for copper ingots, pig lead, mercury, tin, zinc ore, and slab zinc, as indicated by the accompanying table of imports. The government assists the mining industry principally through the medium of the Bureau of Mines of France (Direction des Mines de France). This bureau grants concessions for exploratory work, maintains inspection services under the supervision of the Minister of Public Works, levies and collects taxes on mining properties, conducts geological investigations, and collects and publishes, through the Annales des Mines, monthly and annual statistics of the mineral industries. The French Bureau of Mines is assisted, in an advisory capacity, by three agencies—

[1] Encyclopédie Larousse, Paris.
Comité d'Études Minières pour la France d'Outre-Mer, Annuaire, 1935, pp. 9–11, 24–30.

the General Council of Mines, the Advisory Mines Committee and the Advisory Coal Committee.

As a regulatory body, the National Office of Liquid Fuels (Office National des Combustibles Liquides), was organized to control and regulate petroleum imports, recommend duties thereon, regulate stocks, and maintain and supervise internal distribution of petroleum.

In 1931 the Committee for Mining Investigations of French Colonies (Comité d'Études Minières pour la France d'Outre-Mer) was instituted at Paris for the purpose of studying all problems concerning the prospecting, mining, and utilization of mineral resources of French Colonies. This agency issues the "Chronicle of Colonial Mines" (La Chronique des Mines Coloniales), a monthly bulletin which contains statistics of production, exports, and imports with reference to French colonial possessions and occasional contributions on geologic subjects. An annual publication is likewise prepared, which furnishes production and trade statistical data.

IMPORT TRADE OF FRANCE BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934[1]

Classified group	1932	1934
Metals		
Aluminum (metric tons)		
Bauxite	250	3
Alumina	4	10
Ingots and scrap	283	158
Sheets, beaten, wrought, and melted	576	817
Wire	24	40
Sulphates (including those of ammonia and potassium)	201	483
Hydrates	17	11
Antimony (metric tons)		
Ore	988	1,788
Crude and regulus	646	699
Oxide	54	73
Sulphide	3	3
Chrome ore (metric tons)	13,399	27,168
Copper (metric tons)		
Ore, matte, etc	3,005	696
Ingots, copper cement, and alloys of zinc, tin, and aluminum	99,873	106,879
Bars	3,475	3,780
Wire	1,099	1,288
Sheets	2,541	2,617
Scrap	7,529	8,267
Iron ore (metric tons)	334,928	941,058
Pig iron (metric tons)		
Ordinary and hematite	58,585	65,284
Spiegeleisen	3,259	1,046
Ferroalloys (metric tons)		
Ferroalloys of aluminum, silicon-aluminum, chrome, manganese, molybdenum, silicon, silicon-spiegeleisen, titanium, tungsten, uranium, and other	1,547	1,261
Scrap (iron and steel, cast iron, filings, scales, and waste)	95,926	69,989
Lead (metric tons)		
Ore, matte and slag	13,121	25,713
Pig lead (including argentiferous, non-argentiferous, and antimonial)	111,089	100,373
Sheets	311	412
Scrap	1,789	851
Manganese (metric tons)		
Ore	349,169	582,754
Dioxide (pure and impure)	555	43
Mercury, quicksilver (kilograms)	151,600	107,300
Nickel (metric tons)		
Ore	19	. . . . .
Matte and speiss	1,947	4,336
Ingots	992	1,645
Ingots, alloys	131	109
Sheets	166	187
Sheets, alloys	689	513
Wire, pure	63	87
Wire, alloys	48	50
Oxides	17	24
Platinum (kilograms)		
Unwrought and scrap	998	1,164
Drawn, in sheets	79	45
Drawn and rolled, other	45	96
Rolled, in leaves (thousand francs)	4	8
Tin (metric tons)		
Ore	361	498
Pigs and bars	8,970	9,759
Pigs and bars, alloyed with antimony	160	184
Sheets, beaten in leaves, and other	103	91
Wire	8	3
Scrap	111	186
Vanadium, oxide (metric tons)	. . . . .	1
Zinc (metric tons)		
Ore	123,150	166,485
Spelter, bars	47,640	42,001
Spelter, scrap	4,989	5,700
Sheets	2,251	3,100
Lithopone	184	124

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

IMPORT TRADE OF FRANCE BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934.[1]—(*Continued*)

Classified group	1932	1934
Nonmetals		
Asbestos (metric tons)		
Unmanufactured	6,688	10,221
Spun and woven (lace, braid, tissues, thread, and cord)	131	74
Paper and board	214	186
Barium minerals (metric tons)		
Barite, natural and crushed	32,127	31,366
Witherite	152	300
Other compounds	2,390	1,726
China clay (metric tons)	56,561	60,119
Coal (metric tons)		
Coal	17,863,861	16,695,498
Coke	1,963,080	2,198,794
Briquets	1,090,757	940,523
Graphite (metric tons)	2,813	3,674
Gypsum (metric tons)		
Crude and calcined	4,914	5,715
Alabaster	36	45
Magnesite (metric tons)		
Crude	490	2,534
Calcined, pure, and natural	11,337	11,689
Mica (metric tons)		
Unmanufactured	179	796
Sheets, plates, and other manufactures	36	46
Nitrate of soda (metric tons)	304,213	131,952
Petroleum (barrels)		
Crude	7,244,000	30,253,000
Gasoline	17,254,000	9,084,000
Kerosene	1,187,000	298,000
Lubricating and other heavy oils	1,381,000	1,083,000
Fuel oil	4,454,000	1,758,000
Gas oil	2,577,000	1,828,000
Benzol for motors and fuel	(Not avail.)	160,000
Benzol for industrial purposes	(Not avail.)	10,000
Vaseline and paraffin oils	(Not avail.)	8,000
Road oils and soft pitch (metric tons)	84,886	52,305
Asphalt, mastic and rock (metric tons)	16,837	6,708
Petroleum coke and hard pitch (metric tons)	8,657	19,009
Petrolatum (pounds)	52,000	67,000
Paraffin wax (pounds)	11,479,000	3,612,000
Lignite wax (pounds)	(Not avail.)	211,000
Phosphates (metric tons)		
Phosphate rock	862,729	942,760
Superphosphates	129,025	82,859
Basic slag	64,506	54,504
Potash salts (metric tons)		
Alunite	2	6
Kainite	58	.....
Carbonate	812	747
Caustic	199	82
Chlorate	6	17
Chloride (carnallite and sylvinite)	2,291	10,274
Chloride (potassium proper)	5,600	505
Chromate and bichromate	469	374
Nitrate	10	1
Sulphate	598	235
Permanganate	1	1
Pyrites, iron (metric tons)	555,242	438,445
Sulphur (metric tons)		
Rock	45,892	198,734
Crude	103,846	133,795
Refined lump	245	3,056
Flowers of	1	2,551
Precipitated	58	84
Talc (metric tons)	3,513	3,532

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

PRODUCTION IN GERMANY OF 32 MAJOR INDUSTRIAL MINERALS
(In Metric Tons)

Commodities	1932	1933	1934	Per cent of total world[1]
Metals:				
Aluminum	19,300	18,900	37,200	21.8
Antimony				
Bauxite	1,638	[2]	6,560	
Chromite				
Copper[3]	30,741	29,434	25,970	2.0
Iron ore[4]	1,319,142	2,534,768	4,213,869	3.4
Pig iron and ferroalloys[5]	5,281,857	6,856,200	10,542,409	16.8
Lead[3]	68,663	53,660	57,000	4.2
Manganese	12	563	515	
Mercury				
Nickel				
Platinum, (troy os.)				
Tin[3]				
Tungsten[6]			1	
Vanadium				
Zinc[3]	75,275	104,363	131,731	9.4
Nonmetals:				
Asbestos				
Barite	110,466	147,741	354,868	[7]
China clay	524,707	563,219	841,480	[7]
Coal:[8] Anthracite and bituminous	115,179,000	120,253,000	136,228,000	21.3
Lignite	122,647,000	126,794,000	135,995,000	
Fluorspar	45,365	53,689	70,045	[7]
Graphite[8]	20,808	19,755	17,535	[7]
Gypsum[9]	398,500	485,000	810,000	10.3
Magnesite	[2]	[2]	11,010	[7]
Mica				
Natural nitrates				
Petroleum, crude (bbl.)	1,608,000	1,665,000	2,187,000	
Phosphate rock[10]	[2]	[2]	735	
Potash: Equivalent K_2O	871,354	1,026,114	1,329,428	61.1
Pyrites	175,216	189,647	230,149	[7]
Sulphur[11]	20,250	25,250	27,760	[7]
Talc and soapstone[8]	3,197	5,107	6,934	[7]

[1] Calculated on basis of 1934 production; items representing less than one-half of 1 per cent not calculated.
[2] Data not available.
[3] Mine production in terms of metal content.
[4] Exclusive of manganese ore carrying 12 to 30 per cent manganese.
[5] Including the Saar.
[6] Concentrates containing 60 per cent WO_3. Saxony only.
[7] Not susceptible of calculation.
[8] Bavaria only.
[9] Figures supplied by Deutscher Gips Verein, E.V., Berlin, Germany. Figures are exclusive of rock gypsum mined and used by cement, paint, and other factories from their own quarries.
[10] Prussia only.
[11] Recovered from gases, by-products of barium products, and from pyrites.

GERMANY[1]

RAW-MATERIAL PROBLEM

The outstanding development in the German metal industry in the past few years has been the attempt to solve the serious problem of procuring adequate supplies of indispensable imported metals and ores upon which the German metal-manufacturing industry depends. The deterioration of foreign trade, particularly of export trade in manufactured products, and the resultant acute shortage of requisite foreign exchange have been prime causes of the difficulties confronting industry. It has become clear that although production has gained markedly notwithstanding the foreign-exchange shortage, the future course not only of the metal industry but German economy in its entirety will depend very largely upon a restoration of foreign trade, with the concomitant benefits of increased supply of foreign currencies to pay for imports of metal and other indispensable foreign raw materials.

OFFICIAL TRADE CONTROL

Since metals and ores rank among the most important group of raw materials imported by Germany, being exceeded in total value only by textile raw materials, they were among the very first to be subjected to a system of import and trade regulations for conserving the available supply and protecting foreign-exchange resources. This system, first loosely established in the latter part of March 1934, was steadily extended to other products as foreign trade continued to disintegrate, and finally, in September 1934, under the so-called "New Plan," it was made to apply to the entire range of imported raw materials; in consequence, 25 separate trade-control boards were established to specialize in each principal commodity group, with one such board for metals. As part of this elaborate scheme for control of raw materials, consumption quotas (changeable each quarter,

[1] Sydney B. Redecker, American Consul, Frankfurt-am-Main, and C. W. Wright, American Vice Consul, Berlin.

depending upon relative need and available supply) were established for the various kinds of metals; restrictions were imposed upon the use of imported metals for certain purposes by compelling substitution of domestic metals, notably aluminum for copper; and, in general, the entire trade was subjected to very close official supervision—importers, dealers, and consumers being required to procure official approval for import purchases, and to report trade transactions, as well as their statistical position as regards consumption, stocks, and needs. The curtailment of imports caused domestic German metal prices in the summer months of 1934 to rise markedly above international levels and led to a severe price control that effected a gradual return of prices to lower levels.

All these official control measures, foreign-exchange difficulties, shortages and threatened shortages, and interruptions in raw-material supply have had serious effects upon the metal industry.

ESTABLISHMENT OF SYNDICATES WITHIN THE PRINCIPAL MINING INDUSTRIES

A reorganization of the German mineral industries was initiated soon after the World War, when well-studied plans were made to rebuild the national industries that had suffered most from the loss of territory and of world markets. At that time there was a general harmonious effort by the political and economic forces to carry out these plans. The national economic program was one of general interest where "Gemeinnutz geht vor Eigennutz," or "Common interest takes the place of individual interest." On the one hand, however, there were the tendency toward socialization of industry by the workers and on the other uniting and strengthening of industrial operations by the larger industrial trusts. The best samples of reorganization of large industry to meet both democratic and political tendencies are found in the coal-mining and potash-mining groups. To accomplish this, the Reichstag passed the law of Mar. 19, 1919, for compulsory control of coal-mining activities by the state, marking the first step toward socialization of the mining industry. The Reichstag then attempted to regulate technical questions as well as market prices and established safety commissions that were useless, so that the industry itself was handicapped by

too much government interference. This interference, however, helped to bring the larger coal operators together and resulted in the establishment of syndicates through which production was controlled by obligatory cartels fixing sales quotas as well as market prices for both coal and lignite. These cartels were composed of the largest producers, who persuaded the government to make them obligatory to eliminate competition.

The potash and other mineral industries also united and followed the same "Bergbaupolitik" or mining-industry policy by establishing similar syndicates for the control of production, sale prices, and quotas within their respective industries. Today there are 12 such syndicates within the mining industries, namely:

1. Rheinish-Westfälisches Kohlen-Syndikat, Essen Postfach 937.
2. Oberschlesisches Steinkohlensyndikat G.m.b.H., Gleiwitz, O/S., Postschliessfach 466/67.
3. Niederschlesisches Steinkohlen-Syndikat G.m.b.H., Waldenburg/Schles., Postfach 9/10.
4. Sächsisches Steinkohlen-Syndikat G.m.b.H., Zwickau i. Sa., Bahnhofstr. 66.
5. Niedersächsisches Kohlen-Syndikat G.m.b.H., Hannover, Hindenburgstr. 2.
6. Mitteldeutsches Braunkohlen-Syndikat G.m.b.H., Leipzig, Nordplatz 11/12.
7. Ostelbisches Braunkohlensyndikat G.m.b.H., Berlin NW. 7., Bunsenstr. 2.
8. Rheinisches Braunkohlensyndikat G.m.b.H., Koeln/Rh. Apostelkloster 21/5.
9. Kohlensyndikat für das rechterheinische Bayern G.m.b.H., Muenchen, Ludwigstr. 16.
10. Siegerländer Eisensteinverein, Siegen, Siegstr. 4.
11. Deutsches Kali-Syndikat G.m.b.H., Berlin SW. 11 Dessauerstr. 28/29.
12. Deutsche Steinsalz-Syndikat, Berlin SW. 48 Wilhelmstr. 37/38.

There is, however, a decided distinction between (1) those syndicates based upon government decrees, namely, those for the coal and potash industries, and (2) those based on free contracts that have been built up within an industry, which are per-

mitted to sell their products without government interference as long as they keep within the law. The German mining industries are represented on international cartels by these syndicates.

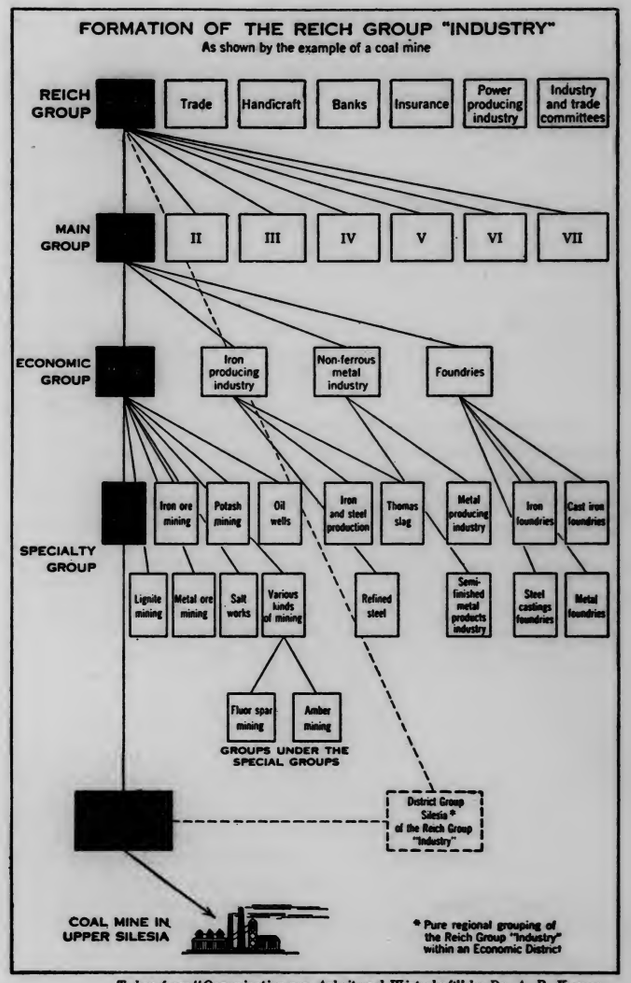
NAZI ORGANIZATION CHART FOR INDUSTRY

The accompanying diagram gives a general idea of the grouping of the mining and related industries into organized branches. At the bottom a coal mine in Silesia is represented, and the diagram shows the ramifications through which the management has contact with the National Socialist Government in carrying out its economic policy. This policy is not an attempt by the state to manage the mining business as some may believe. The state is merely concerned in directing national economy in a way that is best fitted to the requirements of the people and the state itself. Private initiative is not only unrestricted but is promoted by the state as long as it takes into consideration the general economic policy of the state and abides by its laws.

The first place in the scale is occupied by the six Reich groups (Reichsgruppen)—industry, trade, handicraft, banks, insurance, and power-producing. The Reich groups are divided into main groups (Hauptgruppen), and these main groups are again divided into economic groups (Wirtschaftsgruppen). The economic groups are made up of the specialty groups (Fachgruppen) and other groups coming under the specialty groups (Fachuntergruppen). The main work of the organization is concentrated in the economic groups, which are the basis of German industrial organization.

The final step in this new system was the law of Mar. 14, 1933, when the Minister of Economics divided German industry into 14 economic districts (Wirtschaftsbezirke). These districts correspond to the districts of the trustees of labor (Treuhänder der Arbeit) and to the districts of the provincial labor offices (Landesarbeitsämter). Since four of the economic districts have two economic chambers (Wirtschaftskammern) each, there are altogether 18 district economic chambers. The smallest regional unit is the district of a chamber of commerce and industry (Industrie-und-Handelskammer).

An important feature in the organization of German industry is the fact that the economic groups, together with their government representatives of the different branches, are joined into



Taken from "Organisation von Arbeit und Wirtschaft" by Dr. A. B. Krause

economic chambers (Wirtschaftskammern) within the separate economic districts. The director of the economic chamber is the chairman of the chamber of commerce and labor and is assisted by an advisory council. The economic chamber represents the working organization of all the economic organizations within a district. Through it, the different interests of the individual members can be balanced, and in this way the economic chambers are an important factor in carrying out the government economic policy.

The appointment of those who administer these groups is made by the Minister of Economy, but their selection is usually left to the head of the group immediately above. Thus the head of the mining group will select the men to take charge of each of the specialty groups, and care is taken to place men well experienced in the administration of the industry they are to represent. In the local mining districts, the manager of one of the mining or smelting companies is usually appointed chairman of the economic chamber, and the members of the economic chamber are representatives of the other mining industries within the district. The specialty groups for the mining industries and the district divisions are as follows:

Coal Mining:

Ruhr district	Specialty group for coal-mining industry
Aachen district	Specialty group for coal-mining industry
Saar district	Specialty group for coal-mining industry
Upper Silesia	Specialty group for coal-mining industry
Lower Silesia	Specialty group for coal-mining industry
Saxony	Specialty group for coal-mining industry
Lower Saxony	Specialty group for coal-mining industry

Lignite Mining:

Middle Germany district	Specialty group for lignite-mining industry
Rhineland districts	Specialty group for lignite-mining industry
South Germany	Specialty group for lignite-mining industry

Iron-ore Mining:

Siegen district	Specialty group for the iron-ore-mining industry
Wetzlar district	Specialty group for the iron-ore-mining industry
Middle Germany district	Specialty group for the iron-ore-mining industry
South Germany district	Specialty group for the iron-ore-mining industry

Other Mining:

Specialty group for the nonferrous metal-mining industry
Specialty group for the potash-mining industry
Specialty group for the salt-mining industry
Specialty group for the petroleum-wells industry
Specialty group for the fluorspar-mining industry Erfurt
Specialty group for the amber-mining industry

Under the economic group "iron-producing industries" there are three specialty groups and two district divisions, as follows:

1. Iron and steel production
2. Refined steel
3. Thomas slag

} Northwest district Saar district

The economic group foundries or smelting and melting industries consist of four specialty groups:

1. Iron foundries
2. Steel-casting foundries
3. Cast-iron foundries
4. Nonferrous-metal foundries

The first and fourth groups have several subgroups, but there are no divisions into districts.

These various specialty groups have great significance in the present regime, inasmuch as they are entrusted with the new task of cooperating in the control of the raw-material supply and the manufacture of substitute materials. They function as the machinery to carry out the government economic policy and to hand down government commands quickly from top to bottom, without publicity where advisable.

These Reich groups or national economic chambers participate in matters of broad political significance and were established to carry out the general ideas of the National Socialist Party by advice and persuasion. They are independent of the syndicate or cartel organizations that control sales quotas and market

prices as well as of the metal-control boards (Überwachungsstellen) that control foreign purchases of raw materials and their consumption in Germany.

NAZI LABOR ORGANIZATION

The abolishment of German labor unions and associations was effected in May 1933, and the National Labor Law eliminating strikes made operative Jan. 20, 1934. In May 1934, the Arbeitsfront was established. At the end of 1934, the National Socialist Party dissolved the former employers' associations (Arbeitgeberverbände), which as opponents of the labor unions (Gewerkschaften) supported the wage policies of the operators of the industry. These employers' associations were also included in the Arbeitsfront. The present object of the Arbeitsfront is to look after the interests of the workers and employees, principally from a sociological point of view, including social, cultural, and recreational activities. In reality, however, this new organization attempts to enter into all labor problems. Questions as to wages, hours of work, suspensions, vacations, and so on are still handled by the National Labor Board (Arbeitsamt). The Insurance Administration (Reichsversicherungsamt) takes care of 95 per cent of the workmen's insurance.

The most drastic action taken by the present government was the elimination of strikes and lockouts effected by the labor law of Jan. 20, 1934, which has resulted in great benefit to industry and a somewhat questionable benefit to labor.

This regimentation of workers and employers under a central national organization, with its elimination of all labor unions, has been carried out in less than 2 years, but not without internal fights for control between labor and capital. The fights still continue in a small way.

The National Labor Law gives a dominating position to the trustees of labor, who are appointed for each economic district to settle the disputes between labor and industry that cannot be settled privately.

On Mar. 21, 1935, another decree was issued, the object of which was to unite both industry and labor under a Federal Economic and Labor Chamber through which the social and economic policies of the National Socialist Party could be promulgated, particularly for labor.

These new labor laws and the creation of the Arbeitsfront have been promulgated to bring about a more effective and controllable contribution by the individual workers, and the employers as well, toward the rebuilding of a more powerful and united nation and the development of a more cultured, healthy race.

It is to be noted that the Arbeitsfront and the National Economic Chamber (Reichsgruppen) are independent organizations, the Arbeitsfront having to do with the labor interests only and the economic chambers with the national economic policy only. The clearing house for labor, however, is the Landes-Arbeitsamt, long-established, nonpolitical organization with branches in all working centers, which helps to place unemployed men, supplies workmen, and administers unemployment insurance.

METALS-CONTROL BOARD

Some years ago, owing to a shortage of foreign exchange, Germany realized the necessity of reducing its dependence on imports, of regulating imports of raw materials, and of obtaining imports as far as possible from countries buying German products. Following the general plan already started for other commodities, a supervisory board for the nonprecious metals (Überwachungsstelle für die unedlen Metalle) was established by a ministerial decree of Mar. 26, 1934, and independent of this control board was an advisory council or "Beirat" composed of producers and sellers of ferrous products. Besides controlling imports, this board also controls domestic consumption. Consumers must apply for a permit to purchase their requirements, whether of domestic or foreign origin, and state whether these imports are needed for domestic use or for export in manufactured articles. If the raw material is to be exported in fabricated form, the permits are granted without much delay, but if the raw material is for domestic use such permits depend upon the urgency of the import as well as the purpose.

Through this board the government is in a position to regulate the source of imports and the accumulations of stocks and direct imports from countries where there is a market for German-manufactured products rather than from countries with which Germany has an unfavorable balance of trade. This board has full powers for obtaining all requisite statistical data, such as metal stocks on hand, commitments, future needs, and so on,

and all importers are required to furnish complete and accurate information.

This control system, which tends to equalize trade but at lower levels, has had very marked effects upon the metal industry in Germany and has seriously disturbed the flow of requisite supplies of raw materials required by German smelters and metalworking plants. In some instances it has brought the trade in future purchases to a standstill, since importers, not knowing precisely what amount of exchange they will be able to obtain, are unable to make commitments for future imports. Importers must pay cash with orders, while the exporters often have to wait long periods for payment, which has discouraged trade and led to the numerous barter deals that now dominate the market.

The world metal quotations serve as a basis for computation of sale prices, and for each metal there is a prescribed formula to determine its selling price. The metalworking industries cannot buy even the smallest quantities of the metals without permission from the Metals-control Board, and, as it is not certain that these permits will be forthcoming, most metal users therefore do not place their orders until after receipt of the permission. Each consumer must give accounts of metal consumed, delivered, and stocks on hand to the control board and must show that a sufficient amount of foreign exchange is to be received to cover the raw-material purchases.

Since Germany has a distinctly unfavorable balance of trade with the United States, exports of these metals from the United States have shown a marked decline in recent years, although there were marked increases during the first quarter of 1936. This new national trade doctrine in Germany has the advantage of giving Germany a means for expanding its export trade through reciprocal-trade agreements with foreign countries, based upon Germany's furnishing manufactured products in exchange for imports of raw materials. The effect of this policy as applied to the metals group has been a much larger export of semifinished and finished metal products than is necessary to pay for the imported raw materials.

DOMESTIC CARTELS

Previous to the World War and in the early postwar period, cartels were allowed to develop virtually without government interference, and in 1925 there were 3,000 in Germany, extending

into all branches of industry. Under the "liberalistic" republican regime the cartels were looked upon as capitalist weapons for the exploitation of consumers, and in November 1923 legislation was passed favoring free competition and subjecting cartels to direct control by the state. The policy of the present government started with the law of July 15, 1933. This is a compulsory cartel law (Zwangskartellgesetz) by which the Minister of Economics is authorized (1) to compel any individual or organization to join existing cartels or to form new ones if such action seems desirable in the interest of national economy; (2) to regulate the rights and duties of cartel members; and (3) to forbid the establishment of new firms or the expansion of the productive capacity of already existing concerns in any branch of industry.

This evident repromotion of cartels for certain specific mineral commodities was based on the contention that, in view of Germany's critical economic position, government regimentation of the country's resources was necessary. The new law stimulated the formation of voluntary cartels among producers, who acted voluntarily to avoid having a governmental cartel forced upon them. However, for the mineral industries, most organizations belong to the longer-established selling Vereins or syndicates, the so-called cartels of higher order, which prohibit direct sales by their members and oblige them to sell through a central sales office.

With the growth of the cartels, there was also an upward movement in prices, caused by increased market demands due to government expenditures and the diminished imports of raw materials due to lack of foreign exchange and reduced exports. To check this upward tendency the office of the Federal Price Commissioner (Reichskommissar für Preisüberwachung) was established on Nov. 15, 1934, and subsequent decrees were enacted giving this office authority to protect the public against undue price increases. All organizations were forbidden by law to fix maximum, minimum, or margin prices in domestic trade unless the price commissioner or his agents previously approved such action. This law gave the commissioner a tremendous power over all cartels, but as he was opposed to the Compulsory Cartel Law of July 15, 1933, the tendency was toward free competition. However, Germany's raw-material situation became progressively more critical, and both the Minister of Economics and the Price Commissioner were forced to adopt further meas-

ures for regimentation both of the domestic and export cartels. These have been incorporated into the present system of economic regimentation to carry out the national program. Today the mineral-commodity prices for the principal products can be raised only by permission of the Minister of Economics, the main object being not to permit an increase in commodity prices without a corresponding increase in wages.

REDUCTION OF IMPORTS AND PRODUCTION OF SUBSTITUTES

Early in 1934, the government, with the help of the industry and of research organizations, drew up plans for studies and experimental plants (1) to produce substitute mineral commodities from domestic raw materials and (2) to increase the capacity of existing mines and plants for producing not only the raw materials that hitherto had been imported, but substitute materials as well. During the last few years much progress has been made in solving the technical problems involved in the production of certain mineral commodities such as gasoline, sulphur, and zinc, and according to official statements it is expected that within two to four years sufficient quantities of zinc and sulphur will be produced to meet consumption demands. Domestic gasoline production will continue to reduce imports (an extensive drilling program is in progress, and several new hydrogenation plants for the manufacture of synthetic gasoline are being built), but only in an extreme emergency will Germany be in a position to do without foreign petroleum products. Much progress is also being made in the output of aluminum, magnesium, and light alloys. Instead of hasty planning to meet an emergency, Germany is building factories and producing and introducing substitute metals and other mineral commodities for domestic consumption now, so that commercial-scale manufacture and use will be delayed to a minimum in case of necessity. It is explained that these substitutes, metals from domestic raw materials, are being produced and put into common use not only because of the lack of foreign exchange but also because of the desire to be prepared for any emergency.

RESTRICTIONS IN THE CONSUMPTION OF NONFERROUS METALS

In general, restrictions have been imposed on consumption of nonferrous metals to prevent use of the deficiency metals for nonessential, wasteful applications, especially those that can be

properly filled by cheaper and more abundantly available domestic materials. Examples include the use of sheet copper and nickel for roofing, handrails, and posts. This was, on the whole, the effect of the first restrictive regulations issued in August 1934. However, a new set of restrictive regulations published May 2, 1935, went still farther and prohibited the use of copper, nickel, lead, tin, quicksilver, chrome, and cobalt in any form, either pure or in alloys, for the manufacture of products for domestic use except when unavoidable. In fact, these regulations restrict employment of some metals in long-established, essential uses, such as mercury in thermometers, tin in bearings, and copper for electric conductors and wire. Some of these restrictions have created new technical problems and have directly stimulated a search for substitutes. As a result of these government measures, a number of low-tin solders and solders without tin have been developed and are giving excellent service. To effect additional economics in the use of tin, stainless-steel milk cans are about to be introduced and aluminum-plate cans are already in use.

None of these restrictive measures applies to the manufacture of products destined for export, but, as already stated, proof of the authenticity of export orders must be furnished. The purpose of these restrictions is more educational than practical. The intention appears to be to show manufacturing industries that they can get along with the reduced amount of metal available. The actual control of consumption was embodied in the regulations assigning definite quotas to metal-fabricating industries on the basis of their ascertained requirements during the key year, 1934. These quotas, first assigned in 1934 at 100 per cent of ascertained consumption during the first quarter of that year, were gradually restricted until by a decree of Apr. 29, 1935, they were reduced to 30 per cent for copper, 10 per cent for nickel, and 30 per cent for tin.

The restrictions do not apply to the production of metal wares for export. Preferential treatment is also accorded to manufacturers filling government orders. Their requirements for raw materials are supplied without any restrictions or regard to previous consumption. In effect, this establishes a right of way for government metal requirements, a condition reflecting a serious shortage of nonferrous metals on the one hand and extensive ordnance manufacture on the other.

The shortage of metals, it must be remembered, is only relative as contrasted with the enormously increased requirements. Far from signifying a metal famine, it shows that official Germany is consuming, or perhaps partly accumulating, greater quantities of raw materials than ever before, whereas private use has been restricted to the point of imposing hardships upon the manufacturers and consumers of ordinary metal products.

FINANCIAL SUPPORT OF MINING OPERATIONS BY THE GOVERNMENT

A number of the nonferrous mines, metallurgical plants, and coal mines have been owned and operated by the National Government, particularly in Prussia. To bring the nonferrous metal operations under one direction a large government shareholding company, the "Preussag," was formed in 1923 with headquarters in Halle. This company has a capital of 80 million reichmarks and controls large interests in the German lead-zinc, coal, and potash industries. The operations of the company are under the supervision of the Oberberghauptmann of the Prussian Bureau of Mines, but for the direct management of all of the mines and smelters there is a Generaldirektor or general manager.

The government-owned coal mines are in the hands of another shareholding company, the Hibernia, which has a capital of 150 million reichsmarks. The mines are located principally in Westphalia and produce about 9 per cent of the German coal output. Another state-owned company is being formed to operate the coal mines of the Saar district.

The Vereinigte Aluminiumwerke, the principal producer of aluminum, which owns the large plants at Lauta, is capitalized at 24 million marks and is entirely owned by the state.

For the production and development of copper mines there is the "Studien Gesellschaft Deutscher Kupfer Bergbau," which is financed by the government; 3 million marks were allotted to this company in 1935. The management is assigned to the Mansfelder Kupferschiefer A.G.

Besides carrying on actual mining operations, the state is subsidizing all metal mines that cannot operate at a profit because of the low metal prices. Such mining companies receive a premium per ton mined, based on their mining costs, that is sufficient to cover any operating loss and amounts necessary for amortization

but leaves little or no margin of profit. In some instances these subsidies to a single mining company total many millions of marks a year. The mine operators, however, would prefer to have higher metal prices in Germany rather than the premium, which is paid by the government or taxpayer. Owing to the devaluation of foreign currencies, particularly the dollar and the pound, metal prices in German marks have dropped; in addition, there is no import duty on most of the raw metals. As more metal is imported than produced, tariffs on the raw materials would be a big handicap to the industry as a whole and would result in higher prices to domestic consumers for the metal products.

STATE ORGANIZATIONS FOR THE MINING INDUSTRIES

In Prussia both the Bureau of Mines and the Geological Survey belong to the "Abteilung-Berg, Hütten- und Salinenwesen" (Mining, Metallurgical, and Saline Industries Branch of the Reich- und Preussische Wirtschaftsministerium (Ministry of Economics). The Oberberghauptmann is in charge of this branch, which has its head-quarters in Berlin. Under this office is the Geological Survey (Geologische Landesanstalt), also in Berlin, and five principal district offices of the Bureau of Mines of Oberbergämter under which there are 5 to 21 Bergreviers or section offices as follows:

Oberbergamt Zu	Number of Bergreviere
Breslau for Silesia	7
Halle for Saxony	8
Clausthal-Zellerfeld for the Harz	5
Dortmund for Westphalia	21
Bonn for Rhine Province	16

There is a Berghauptmann in charge of each Oberbergamt or district office and an Erster Bergrat in charge of each sectional office or Bergrevier.

In the State of Bavaria there is an Oberbergamt at Munich and four Berginspektion offices under it. Saxony has an Oberbergamt at Freiberg and four Bergämter within the state. The state of Thüringen has three Bergämter and the states of Württemberg, Baden, Hesse, Brunswick, and Anhalt each have one Bergamt or Bergrevier office.

The Geological Surveys.—The Prussian State established a geological survey, the Preussische Geologische Landesanstalt, in 1873, with headquaters in Berlin, and similar geological surveys were established in the other states of Bavaria, Saxony, Thüringen, Württemberg, Baden, Brunswick, and Hesse.

The geological surveys make field studies, reports, and geological maps throughout the states and conduct special scientific and economic investigations within areas where they are desired. Their principal work, however, has been to complete a general geological map of Germany on the scale of 1/25,000. This work has been in progress for 60 years, and it will take another 30 years to finish it. In general, the functions of this department correspond to those of the United States Geological Survey.

The Mining Bureaus.—The establishment of the Prussian Bureau of Mines and those of the other states antedates that of the geological surveys, and for certain states the records show that mining bureaus existed back in the Middle Ages. These bureaus establish mining laws; approve mining concessions, mining rights, and the work done upon the concessions and rights; and inspect the mines to see that the laws and regulations in regard to safety are followed. They also collect and report upon mineral-production statistics and the general progress in the individual mining industries.

The work of these bureaus or mine inspectors' offices corresponds to that of the state mine inspectors and state mining bureaus in the United States, except that they do not make technical investigations in mining and metallurgy, and most of their time is given to weekly or often daily inspection trips to the mines within their particular section.

The mining bureaus in Germany have under their general direction the state mining schools, 14 in all, at Bochum, Essen, Duisburg, Siegen Dillenburg, Aachen, Mors, Cologne, Eilsleben, Waldenburg, Peiskretscham, Saarbrücken, and Zwickau.

The plans of the present government are to unite all the mining bureaus and geological surveys under a National Bureau of Mines.

The Kaiser Wilhelm Institute.—For research work in mining and metallurgy, the Kaiser Wilhelm Institute was established in Berlin in 1910. The institute has several branches, of which possibly the most important at present is that for research in iron

(Eisenforschung). The Association for Iron and Steel Plant Operators (Verein Deutscher Eisenhüttenleute), through the Kaiser Wilhelm Institute, is carrying out research work in the fields of ore dressing of low-grade iron ores, of devising metallurgical processes for reducing iron ores and for formation of various iron alloys and of heat treatment; mechanical testing, and physical and chemical research on steel. The work of the Kaiser Wilhelm Institute corresponds to that carried on by the Mellon Institute of Pittsburgh and by the experiment stations of the United States Bureau of Mines. Research work on coal is conducted by the branch of the Kaiser Wilhelm Institute at Mülheim, where special studies on coal hydrogenation have been in progress for some years. A branch of this institute was established in 1935 at Stuttgart for investigations of the nonferrous metals.

Mining and Metallurgical Associations.—The "Gesellschaft der Deutschen Metallhütten und Bergleute" of Berlin is the largest such organization in Germany and corresponds to the American institute of Mining and Metallurgical Engineers in the United States.

The "Verein der Deutschen Eisenhüttenwesen" in Düsseldorf is the principal technical group for the iron and steel industry. For the iron foundrymen there is the "Verein der deutschen Eisengiessereien" in Düsseldorf.

Those interested in nonferrous metal studies belong to the "Deutsche Gesellschaft für Metallkunde" at Wilmersdorf near Berlin, and nonferrous metal foundrymen to the "Verein der deutschen Giessereifachleute" in Berlin.

The coal operators also have an important association, the "Verein für die bergbaulichen Interessen," in Essen. Members of the lignite industry may join the "Braunkohlen Industrie Verein" in Halle and potash operators the "Deutscher Kaliverein" in Berlin.

The organizations of local interest, particularly for the mine and mill operators, are

Berg-und Hüttenmännischer Verein in Wetzlar.

Berg-und Hüttenmännischer Verein in Siegen.

Verein für die Berg-und Hüttenmännischen Interessen in Aachener Bezirk.

Oberschlesischer Berg-und Hüttenmännischer Verein in Gleiwitz.

IMPORT TRADE OF GERMANY BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934[1]

Classified group	1932	1934
Metals		
Aluminum (metric tons)		
Bauxite and cryolite	200,731	326,465
Crude and alloys	48	2,737
Sheets and plates, unworked	178	153
Wire	19	9
Powdered	1	4
Foil	214	177
Sulphates, etc., including refined bauxite	224	52
Scrap	1,720	3,672
Antimony (metric tons)		
Ore, including arsenical ore	148	400
Regulus and scrap	1,252	2,789
Chrome ore (metric tons)	42,653	76,983
Copper (metric tons)		
Ore, including burnt cupreous pyrites	237,878	324,921
Rough copper and alloys	131,128	180,247
Coin and scrap	17,527	14,039
Bars, sheets and other pieces forged or rolled	129	56
Wire and iron wire with copper woven over it	80	41
Wire, cemented	4	.....
Coarse tubes	99	34
Iron ore (metric tons)	3,451,608	8,264,605
Pig iron (metric tons)	62,628	90,840
Ferroalloys (metric tons)		
Ferrosilicon, manganese, chrome and other alloys	13,704	22,147
Scrap, scale, and filings of cast iron and other scrap	99,135	500,872
Lead (metric tons)		
Ore	67,187	82,032
Pig, alloys, and scrap	50,657	48,554
Sheets, etc	5	21
Pipes and other rough lead ware	178	105
Manganese ore (metric tons)	106,779	224,745
Mercury, quicksilver, and amalgam (metric tons)	357	650
Nickel (metric tons)		
Ore	17,698	37,609
Crude scrap and coin	2,324	5,388
Bars, rods, and sheets	71	72
Wire	51	63
Platinum, metals, alloys, and other ware (kilograms)	3,372.9	2,310.7
Tin (metric tons)		
Ore	1,858	602
Crude, scrap, and alloys	12,110	13,470
Sheets	3	4
Wire	2	.....
Foil	9	14
Tungsten (metric tons)	1,714	4,385
Zinc (metric tons)		
Ore	59,492	127,310
Crude and other	101,509	107,243
Alloys, dust, scrap, etc	279	196
Sheets	6,017	8,051
Lithopone	3,649	4,488
Nonmetals		
Asbestos (metric tons)		
Unmanufactured	7,582	20,154
Spun and woven	20	17
Paper and board	37	53
Cement, including paint products	31	22
Barium minerals (metric tons)		
Barites and celestites	4,557	3,274
Witherites and strontianites	1,015	1,411
Chlorides	.....	30
Sulphate	4	6
China clay (metric tons)	185,723	183,547
Coal (metric tons)		
Coal, including bunkers	4,203,612	4,861,824
Brown	1,458,442	1,776,880
Coke	727,092	776,336
Briquets	78,669	109,571
Briquets, brown coal	69,121	87,462
Fluorspar, crude, also ground (metric tons)	18	16
Graphite (metric tons)	7,201	13,451
Gypsum (metric tons)		
Gypsum and phosphatic gypsum	9,831	17,944
Alabaster and marble, crude and powdered	30,474	22,494
Magnesite, caustic, dead-burned and crude (metric tons)	34,580	92,830
Mica, unmanufactured (metric tons)	394	1,006
Nitrate of soda (metric tons)	55,214	107,099
Petroleum (barrels)		
Crude	(Not avail.)	1,937,000
Gasoline	9,245,000	9,847,000
Kerosene	806,000	761,000
Lubricating and transformer oils	2,192,000	2,254,000
Fuel oil	1,320,000	2,105,000
Gas and motor oils	2,847,000	4,639,000
Tarry-paraffinic residues	(Not avail.)	1,882,000
Ozokerite, crude, unmelted (pounds)	(Not avail.)	2,915,000
Paraffin wax (pounds)	32,923,000	47,518,000
Petrolatum (pounds)	5,175,000	10,493,000
Petroleum asphalt (metric tons)	25,165	60,430
Asphalt, natural solid and rock (metric tons)	12,259	5,748
Pitch (metric tons)	87,180	(Not avail.)
Phosphates (metric tons)		
Phosphate rock	407,916	831,553
Superphosphates	137,620	86,241
Basic slag	795,757	980,325
Potash salts (metric tons)		
Caustic	118	190
Carbonate and wool grease ash	199	64
Chlorate	9	15
Fertiliser salts	15	
Sulphate	20	
Pyrites, etc. (metric tons)	650,789	987,261
Sulphur, etc. (metric tons)	49,696	52,936
Talc, speckstein, Spanish or Venetian, and crude (metric tons)	18,044	32,525

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

IMPORT TRADE OF GERMANY BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934.[1]—(*Continued*)

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

PRODUCTION IN ITALY OF 32 MAJOR INDUSTRIAL MINERALS
(In metric Tons)

Commodities	1932	1933	1934	Per cent of total world[1]
Metals:				
Aluminum	13,400	12,100	12,900	7.5
Antimony[2]	302	291	249	1.1
Bauxite	86,553	94,818	131,266	9.9
Chromite	.....	.....	.....	
Copper[3]	381	329	394	
Iron ore	412,326	507,995	484,583	
Pig iron and ferroalloys	494,667	566,895	581,455	[6]
Lead[3]	21,615	17,908	19,437	1.4
Manganese	378	4,524	6,941	
Mercury (flasks)	29,480	17,605	12,804	19.1
Nickel	.....	.....	.....	
Platinum (troy oz.)	.....	.....	.....	
Tin[3]	.....	.....	.....	
Tungsten	.....	.....	.....	
Vanadium	.....	.....	.....	
Zinc[3]	32,183	29,139	45,971	3.3
Nonmetals:				
Asbestos	1,284	3,267	2,252	[6]
Barite	21,861	23,444	32,408	[6]
China Clay[4]	31,488	22,808	37,830	[6]
Coal: Anthracite and bituminous	255,000	334,000	295,000	
Lignite	376,000	383,000	409,000	
Fluorspar	6,450	7,714	9,668	[6]
Graphite	2,945	3,200	3,908	[6]
Gypsum	529,821	534,026	458,978	5.8
Magnesite	460	2,187	1,100	
Mica	9	3	5	
Natural nitrates	.....	.....	.....	
Petroleum, crude (bbl.)	208,000	204,000	151,000	
Phosphate rock	.....	.....	.....	
Potash: Equivalent K_2O	3,604	64	193	
Pyrites	516,961	732,701	812,396	[6]
Sulphur[5]	349,976	376,623	343,388	[6]
Talc and soapstone	32,404	34,487	37,671	[6]

[1] Calculated on basis of 1934 production; items representing less than one-half of 1 per cent not calculated.

[2] Approximate recoverable metal content of ore produced (80 per cent of reported content), exclusive of antimonial lead ores.

[3] Mine production in terms of metal content.

[4] Exclusive of following quantities of washed and ground material derived from crude and stocks: 1932, 8,338 tons; 1933, 4,073 tons; 1934, similar data not available.

[5] In addition, the following quantities of ground rock are reported: 1932, 25,522 tons; 1933, 24,963 tons; 1934, 22,170 tons.

[6] Not susceptible of calculation.

ITALY

The problem of maximum exploitation of Italy's mineral resources due to the pressure of military needs prompted the Council of Ministers on Dec. 4, 1935, to take measures for developing and regulating mining activities, as well as imports of raw materials, to insure an adequate supply of mineral products to domestic consuming industries. Petroleum products, however, were expected, as these were already controlled by the "Ufficio Combustibile Liquidi" or Petroleum Board, which was organized by decree on Oct. 24, 1935, and which supervises the "Azienda Generale Italiana Petroli," an organization formed in 1926 to regulate the market for petroleum products in Italy, and the "Azienda Italiana Petroli Albania," which has been carrying on explorations of the oil deposits in Albania.

Three new organizations were formed and are described by C. W. Wright, American Vice-Consul, as follows:

1. The "Ufficio Prodotti Minerari" or Mine Products Board, created under the Ministry of Corporations by decree 2154 and published in the Official Gazette of Dec. 27, 1935, the objects being (1) to regulate imports, production, and distribution as well as the financing for import in respect to national needs of mineral products except petroleum and (2) to exercise administrative functions over the two following organizations.

2. The "Azienda Minerali Metallici Italiani," or Italian Mineral and Metals Corporation, a semigovernmental organization created to aid in financing explorations for and the development of mineral deposits, to acquire stock in mining companies and where necessary actually to carry on mining operations.

3. The "Azienda Carbone Italiani," or Italian Coal Corporation, also a semigovernmental organization, was created in August 1935, to develop domestic coal deposits and to strengthen the financial situation of the Società Carbonifera dell' Arsa and the Società Carbonifera Sarda, owners of the principal coal mines in Istria and Sardinia, in order that these companies could enlarge their mine plants and be in a position to increase production materially.

The three new organizations correspond closely to the three organizations already functioning for petroleum products. The general setup is as follows:

Ministry of Corporations

Petroleum Board — Mine Products Board

A.G.I.P.[1] A.I.P.A.[2] A.M.M.I.[3] A.C.A.I.[4]

These alphabetical organizations, although administered by their respective boards, are operated as private industrial companies, only the managers being government employees. Part of the capital is supplied directly by the government, usually as an annual contribution, and the rest by banks and institutions under the control of the government.

Functions of the Petroleum Board.—This board or office is required to ascertain the total home demand for fuel oils, gasoline, and lubricants, inclusive of the needs of the army, navy, air forces, merchant marine, and state railways, and to establish the order of priority in which their requirements are to be satisfied. It studies and coordinates the possibilities for securing supplies from foreign and domestic sources, organizes purchasing services, and provides through existing qualified organizations for the transport by sea and land and the storage of petroleum products. It also controls stocks and fixes prices, differentiating them if necessary according to the class of consumers.

The Director of the Office is assisted by a board representing the Ministries of Finance, the Defense Services, Communications, the General Commissariat of War Munitions, the General Secretariat of the Supreme Defense Commission, the Italian Petroleum Corporation, and the Italian Corporation for Albanian Petroleum.

The office can avail itself of existing industrial and commercial organizations as its executive agencies; the relations between them and the office may, if necessary, be regulated by ministerial decree.

From the date of issue of the decree, free commercial transactions in fuel oils, gasoline, and lubricants ceased. An exception

[1] Azienda Generale Italiana Petroli.
[2] Azienda Italiana Petroli Albania.
[3] Azienda Minerali Metallici Italiana.
[4] Azienda Carboni Italiana.

to the extent authorized by the Ministry of Corporations is made in the case of retail sales. The sale of fuel oils is entrusted to the business organizations concerned (mineral-oil refineries, holders of import licenses, wholesale dealers, etc.) subject to the control of the office. At the request of the Director of the Office, the Ministry of Corporations may insure the supply and distribution of fuel oils by requisitioning them.

Functions of the Mine Products Board.—The Mine Products Board has supervisory control over the production, processing, and distribution of all subsoil products, which include metal-bearing ores, arsenic ore, sulphur, graphite, fuels in solid, liquid, and gas form, asphalt and bituminous rock, phosphates, simple and compound alkaline salts and their associates, kaolin, bauxite, magnesite, fluorine, baritine, talc, asbestos, marl, peat, radioactive substances, mineral waters, natural steam, gas, any other power-producing subsoil products capable of industrial application, and materials for use in building and road construction not otherwise specified. The board gives particular attention to production and supplies of metal-bearing ores, asphalt and bituminous rock, bauxite, and leucite and the development of the national coal and lignite resources.

The primary function of the Mine Products Board is to promote exploitation of national subsoil resources to the highest possible degree and to insure Italian industries of adequate supplies of such products. To this end the Ministry of Corporations is authorized, on the proposal of the Mine Products Board, to requisition minerals through the approved agencies and to order free trade in certain minerals discontinued. Furthermore, the Supreme Defense Committee, the General Commissariat for War Supplies, and all public departments concerned cooperate with the Mine Products Board for the accomplishment of its aims. In detail, the board is charged with the following functions:

1. To oblige holders of mining permits and concessions to resume or intensify operations under penalty of losing the concession.

2. To interrupt or to reduce periods of suspensions of mining operations previously authorized by the terms of Art. 26 of R.D. 1443, July 29, 1927.

3. To propose to the Minister of Corporations the expropriation of mines, quarries, and pits and of ore-working plants to

take over their management or to transfer it to those offering guarantees of a greater productive activity.

4. To propose the requisitioning of mineral products to the Minister of Corporations when an emergency justifies it.

5. To provide for adequate transportation services, by rail or by truck, for such products.

The "Consiglio Superiore delle Miniere" or Superior Mining Board, the Bureau of Mines, the Geological Survey and the Institute for Geophysics will be reorganized to coordinate their activities more closely with those of the Industrial Federations for Mining and Metallurgy and thus enable them to work more effectively with the new Mine Products Board under the Ministry of Corporations.

Since 1933 the mineral industries have been united under cooperative associations, namely, the "Federazione Nazionale Fascista degli Esercanti Industrie Estrattive" for the mining companies and the "Federazione Nazionale Fascista degli Industriale Mecanici e Metallurgi" for the metallurgical companies, which form part of the National Confederation for Industry. Most of the mining and metallurgical companies and operators are now members of one of these organizations. They are at present working with the government in the attempt to make Italy more self-sufficient in mineral products. This effort is considered obligatory because of the shortage of foreign exchange and consequent necessity of throttling down all imports to irreducible minimums. Although the final cost of certain mineral raw materials produced in Italy will be many times higher than the actual purchase price abroad, their production from domestic mineral deposits will aid employment and provide a source of supply in an emergency.

IMPORT TRADE OF ITALY BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934[1]

Classified group	1932	1934
Metals		
Aluminum (metric tons)		
Alumina	2,256	2,134
Alloys in ingots	1	3
Crude and alloys	44	19
Sheets, bars, and alloys	112	64
Wire and alloys	3	2
Powder and alloys	11	7
Scrap	36	4
Antimony (metric tons)		
Regulus	420	136
Oxide	22	101
Copper (metric tons)		
Ore	1,663	16
Ingots, scrap, and alloys	53,157	63,320
Rods and bars of copper and its alloys	830	917
Leaves and sheets of copper and its alloys	1,185	979
Wire and cable	652	649
Tubes or pipes of copper and its alloys	284	206
Iron ore, including iron pyrites (metric tons)	192,307	414,375
Pig iron (metric tons)	47,875	60,394
Ferroalloys (metric tons)		
Spiegeleisen, ferroalloys of chrome, manganese, aluminum, silicomanganese, molybdenum, silicon, titanium, tungsten, vanadium, and other alloys	796	1,649
Scrap iron	474,181	731,768
Lead (metric tons)		
Ore	15,404	37,366
Pig, scrap, and alloys	8,957	6,081
Pipes, sheets, and wire	18	29
Manganese ore, including manganiferous iron ore (metric tons)	28,899	65,284
Mercury, quicksilver (kilograms)	200	100
Nickel (metric tons)		
Scrap, ingots, and alloys	978	1,774
Alloys in bars, sheets, plates, wire, and tubes	93	179
Platinum, bars, dust and scrap, plates not cut, wire, and beaten in leaves (grams)	113,659	424,976
Tin (metric tons)		
Ingots, bars, scrap, and alloys	3,794	4,226
Wire, tubes, and sheets	12	13
Zinc (metric tons)		
Ore	2,748	4,561
Spelter and alloys	2,230	5,272
Bars, sheets, plates and wire	1,285	924
Ashes	711	1,783
Scrap	316	145
Lithopone	1,629	1,472
Nonmetals		
Asbestos (metric tons)		
Unmanufactured	4,703	8,421
Spun and woven	20	23
Paper and board	175	208
Cement products	68	113
Barium minerals (metric tons)		
Carbonate	238	280
Chloride	290	529
Oxide and dioxide	21	47
Sulphate	461	508
Sulphide	6	1
China clay (metric tons)	35,857	52,594
Coal (metric tons)		
Bituminous	6,845,478	10,394,209

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

IMPORT TRADE OF ITALY BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934.[1]—(*Continued*)

Classified group	1932	1934	Classified group	1932	1934
Anthracite	910,092	1,123,375	Other mineral oils	17,000	52,000
Lignite	46,598	48,113	Paraffin wax (pounds)	52,654,000	57,520,000
Brown coal briquets	51,444	51,929	Petrolatum (pounds)	498,000	784,000
Coal briquets	154,887	149,349	Asphalt and bitumen (metric tons)	82,661	113,994
Round briquets	7,264	13,306	Phosphates (metric tons)		
Peat	204	517	Phosphate rock	388,030	697,999
Other coal	1,660	556	Superphosphates (including bone)	21,095	18,164
Graphite (metric tons)	1,000	2,407	Basic slag	37,935	32,563
Gypsum (metric tons)			Potash salts (metric tons)		
Crude	752	6,311	Fertilizer salts	29,057	63,044
Calcined	501	289	Carbonate	1,133	1,535
Magnesite, caustic, pure and impure (metric tons)	2,380	3,720	Chlorate	76	31
Mica (metric tons)			Caustic	2,864	2,569
Unmanufactured	97	138	Pyrites (metric tons)		
In sheets	75	185	Iron	99,735	119,358
Nitrate of soda (metric tons)	29,732	33,262	Cupreous	9,908	105
Petroleum (barrels)			Ash	11	
Crude	890,000	1,001,000	Sulphur, crude, refined, and flowers (metric tons)	5	17
Gasoline	2,762,000	2,959,000			
Kerosene	1,127,000	1,166,000			
Fuel oil	5,558,000	7,476,000			
Lubricating oil	465,000	460,000			

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

PRODUCTION IN JAPAN OF 32 MAJOR INDUSTRIAL MINERALS
(In Metric Tons)

Commodities	1932	1933	1934	Per cent of total world[1]
Metals:				
Aluminum				
Antimony[2]	19	40	26	
Bauxite				
Chromite	12,492	19,897	27,222	4.3
Copper[3]	72,571	69,818	69,212	5.3
Iron ore[4]	627,659	578,937	176,008[5]	
Pig iron[4]	1,200,333	1,620,817	1,938,762	3.1
Lead[6]	6,908	7,609	8,584	
Manganese	26,242	43,535	57,165	1.9
Mercury (flasks)[4]	95	234	196	
Nickel				
Platinum, placer (troy oz.)	267	207	118	
Tin[7]	1,582	1,563	1,500[8]	1.2
Tungsten[9]	84	175	469	2.9
Vanadium				
Zinc[7]	12,000[8]	15,000[8]	20,000[8]	1.4
Nonmetals:				
Asbestos	1,000[8]	1,000[8]	1,000[8]	
Barite[5]	6,569	4,969	5,935	
China clay[10]	418,011	430,930	429,421	11
Coal: Anthracite & bituminous[12]	30,921,000	35,882,000	40,332,000	3.1
Lignite	109,000	116,000	125,000	
Fluorspar[5]	7,577	9,076	12,099	11
Graphite[4]	17,228	23,546	32,263	11
Gypsum	[13]	[13]	[13]	
Magnesite				
Mica[5]	20	23	103	
Natural nitrates				
Petroleum, crude (bbl.)[14]	2,891,000	2,467,000	3,070,000	
Phosphate rock	18,707	34,739	56,500	
Potash: Equivalent K_2O	[15]	[15]	[15]	
Pyrites[4]	733,203	866,537[16]	1,097,290	11
Sulphur[17]	84,530	114,426	128,424	11
Talc and soapstone	[13]	[13]	[13]	

[1] Calculated on basis of 1934 production; items representing less than one-half of 1 per cent not calculated.
[2] Includes Chosen. Approximate recoverable metal content of ore produced (80 per cent of reported content), exclusive of antimonial lead ores.
[3] Includes Chosen. Smelter product. Mine production of Taiwan in terms of metal content reported as 4,417 tons in 1932. Production in 1933 and 1934 estimated at 4,000 tons.
[4] Includes Chosen.
[5] Chosen only.
[6] Smelter output. Includes Chosen.
[7] Mine production in terms of metal content.
[8] Approximate production.
[9] Concentrates containing 60 per cent WO_3.
[10] Including Chosen; partly estimated.
[11] Not susceptible of calculation.
[12] Includes Chosen, Karafuto, and Taiwan.
[13] Data not available.
[14] Including Taiwan and Japanese Sakhalin.
[15] Chosen only. K_2O equivalent not available. Gross weight of alunite reported as follows: 1932, 16,320 tons; 1933, 27,220 tons; 1934, 56,330 tons.
[16] Figures incomplete; output of more important mines only.
[17] In addition, the following quantities of sulphur rock are reported: 1932, 2,633 tons; 1933, 2,700 tons; 1934, similar data not available.

JAPAN

The accompanying production and import-trade statistical tables indicate clearly that Japan's mineral resources are inadequate to supply domestic requirements. Japan is an outstanding example of a major industrial nation that has built up its industries on imported materials manufactured into finished products for home consumption and export trade. In addition to a lack of natural resources, Japan is also without the vast resources of secondary or scrap materials available to industry in such countries as the United States and certain European nations. Hence, the volume of scrap material imported annually has been increasing tremendously, as reflected in the import statistics for 1932 and 1934.

There are few minerals that do not present a problem to Japan's industrial progress. The largest copper deposits in the Far East are in Japan, and from this source the country can, in all likelihood, obtain its essential requirements for a relatively long period. Although its copper resources might well furnish domestic requirements, Japan, nevertheless, is importing larger tonnages annually, as illustrated by the fact that imports of copper ingots into Japan during 1934 were 70 per cent of the smelter production of copper in the country during that year. Japan is self-sufficient in its domestic resources of sulphur, which is consumed in the domestic fertilizer industry and in the manufacture of paper and chemicals, and also constitutes an important item in Japan's export trade.

Reserves of its colonies and Manchuria supplement to only a small extent the essential mineral raw materials of Japan proper. Chosen has richer mineral resources than Japan proper; iron ore and pig iron are shipped from Chosen to Japan, and the former has undeveloped but known reserves of nickel ore and alunite. Taiwan supplies coal and some copper; sulphur is the only other mineral raw material of consequence. Manchuria's mineral deposits will augment supplies available to Japan, but even if exploited to the limit cannot fill Japan's requirements. Its large

iron-ore and coal deposits are now furnishing Japan with large tonnages of these two essential raw materials. Oil-shale exploratory work has advanced, although an exportable surplus for Japan's consumption has not as yet been produced. Development of an aluminum industry in Manchuria, based on allegedly high-grade ores, holds some promise (*Far Eastern Survey, Inst. Pacific Relat.*, vol. 5, No. 2, Jan. 15, 1936).

As indicated, Japan must procure adequate supplies of practically all mineral raw materials if it is to expand or, for that matter, retain its position as an industrial nation. The following editorial on Japanese interest in the iron-mining industry of Malay appeared in the *Straits Times*, Singapore, S.S., of June 11, 1936:

Some uneasiness has been caused in Malaya by the recent announcement that a Japanese syndicate in Singapore has obtained an option on a large area of land in the Kinta district with the object of mining for iron ore. It is true that Japanese attempts to establish sources of supply of essential raw materials have been discouraged in other countries, notably in West Australia where a scheme was launched for iron ore mining on a large scale, and in Timor where the exploitation of an oil field was contemplated. With those of our readers who have written criticizing the local governments for permitting Japanese activities in this country, we would like to see Malaya's mineral wealth worked by British interests. There, however, our agreement ends. We can see no particular peril to Malaya, to the Empire or to any British industry which would be removed by prohibiting Japanese companies mining in this country. If Malaya held a monopoly of the world's iron ore, the position might be different, but it cannot be suggested that if Japan were unable to obtain supplies from this country she would be compelled to go short by a single ton of the amount of iron ore that she requires. She might have to pay a little more for it, but she would not be faced with an actual shortage. Malaya, on the other hand, would be deprived of several million dollars of revenue, since non-Japanese appear to have little interest in the exploitation of her iron-bearing lands.

At the present time there are two large Japanese companies engaged in iron mining in Johore and Trengganu. The Ishibara Sangyo Koshi, Limited, with a paid-up capital of $1,500,200 (Straits), works the Sri Medan mine about 17 miles up river from Batu Pahat and the Taiyo mine, which is situated about 20 miles up the Kemaman River. The Johore property was first worked in 1921 and the latest figures available show that more than 6,000,000 tons of iron ore has been exported and about $3,500,000 paid to the Johore Government in royalty. The Taiyo mine was purchased in 1924 and has produced over 250,000 tons of manganese ore and about 700,000 tons of iron ore involving the payment of well over $500,000 as royalty. The Nippon Mining Company controls the Dungan mine which is also in Trengganu. From this property 500,000 tons of iron ore were exported in 1934. In addition to actual mining, these Japanese undertakings are interested in the shipping business and practically the whole of the ore which they produce is exported to Japan in Japanese bottoms.

Apart from the fact that adequate supplies of ore could be obtained elsewhere if these activities were forbidden, it should be recognized that the Japanese were the first to exploit Malayan ore as an industrial proposition and for several years past they have prospected ceaselessly at considerable expense. The undertakings which we have mentioned are the principal ones but smaller companies are also operating and Japanese capital is behind the whole of Malayan iron ore production which amounted to 988,172 tons in 1932; 766,477 tons in 1933; 1,135,648 tons in 1934; and 1,412,221 tons in 1935; in the same years the production of manganese ore was 9,278 tons, 13,192 tons, 18,650 tons; and 28,091 tons.

It was announced early this year that the governments of Johore and Trengganu might suffer severe loss of revenue as the result of a Japanese scheme to obtain iron ore on a large scale from West Australia. Negotiations were opened with the lease-holders of a property in Yampi, north of Perth, but the matter was brought to the notice of the West Australian Government and a British and Australian concern secured an option over the property. This option was subsequently taken up and the actual mining is now done by this British and Australian undertaking, but the Japanese are purchasing almost the entire output of the property and have been allowed to establish their own wharf and storage depot. The Japanese export the ore in their own ships, buying it at a fixed price per ton. Local opinion favored this scheme in the hope that it would provide a means of bringing relief to the cattle industry which was then languishing for want of markets. It was proposed that Australian cattle should be shipped as deck cargo in the Japanese ore-carrying vessels in the hope of establishing a market for Australian beef in Japan.

GOVERNMENT MEASURES ASSISTING INDUSTRIAL AND EXPORT ACTIVITIES

Special Facilities for Support of Industrial Rationalization Movement.—A number of auxiliary organizations are utilized by the government in promoting its efforts to rationalize industry. Two of these are national in scope and deserve particular notice—the Japan Chamber of Commerce and Industry and the Japan

National Management Union. Among sources that lend themselves to government support as regards technical improvement of industry, research institutions are of chief importance. These contribute primarily to improvement of technical proficiency in the mechanized and chemical industries.

The chief activities of the Japan Chamber of Commerce and Industry are to publicize the recommendations of the Government Industrial Rationalization Bureau. A series of booklets, comprising a regular reporting service, is published and widely distributed to industry. Lectures and classes for the study of rationalization are provided, articles covering this movement in foreign countries are translated, and a movement for rationalization in consumption economy is supported.

The Japan Management Union, though less an organ of industry and less firmly established than the Japan Chamber of Commerce and Industry, represents an active and comprehensive movement to further "scientific management." It is cooperative in its relationship to the Industrial Rationalization Bureau and has as president the Vice-Minister of Commerce and Industry.

The union has succeeded in forming cooperative associations in the principal industrial centers of Japan and has made plans for a comprehensive technical engineering and scientific management service to be provided Japanese manufacturers and distributors throughout the country. The union considers its organization supplemental to that of the Industrial Rationalization Bureau and the various chambers of commerce and industry in the country. Its province lies definitely in the field of scientific study and solution of the problems of manufacturers and distributors.

So far, the work and aims of this union have not received wide public recognition, but with its practical organization well advanced and a cooperative relation established with the Ministry of Commerce and Industry, it appears to be a vital potential force in promoting efficiency in Japanese industry. To achieve its aims, the union makes use of an extensive publicity service, contact with similar organizations abroad, and such means as lectures, special study groups, and exhibitions.

The government gives substantial support to scientific and industrial research bodies in return for the contribution they may make to manufacturing progress in various fields. Foremost among such organizations is the physical and Chemical Research Institute, a great central research body, in conjunction with which is maintained the Physico-Chemical Industrial Development Co. for practical application of research results to industry. In addition, the following government laboratories are considered important institutions:

Electrical Experiment Laboratory, Department of Communication.

Tokyo Industrial Chemical Research, Department of Commerce and Industry.

Osaka Industrial Chemical Research Laboratory, Department of Commerce and Industry.

Nitrogen Research Laboratory, Department of Commerce and Industry.

Ceramics Experiment Laboratory, Department of Commerce and Industry.

Aeronautical Research Laboratory, Tokyo Imperial University.[1]

Metal Materials Research Laboratory, Tohoku University.[1]

Chemical Research Laboratory, Kyoto University.[1]

Through the Industrial Bureau in the Department of Commerce and Industry the government also gives financial support (total for 1933, Yen 150,000) to certain firms for the maintenance of industrial laboratories. The following manufacturers are representative of those encouraged in this way:

Japan Electrolysis Steel Works.
Tobata Metal Casting Co.
Kobe Steel Works.
Tokyo Electric Bulb Manufacturing Co.
Japan Metal Industrial Co.
Japan Oxygen Co.
Japan Compound Chemical Industrial Co.
Imperial Dyestuff Co.
Tokyo Dry Plate Manufacturing Co.
Sakai Chemical Industrial Co.
Chugoku Paints and Pigments Co.

Coordination of Production and Distribution of Exports.—In addition to coordination of production and distribution in relation to export trade, brought about by special means and promul-

[1] Government schools.

gated by export and industrial associations, the government gives definite aid to export distribution. Special facilities are maintained for the benefit of exporters, the chief of which are:

1. The consular and commercial attaché service, approximately as extensive as that of any other country and considerably more extensive in China and other Asiatic markets than that of any other country.
2. A commercial museum system to further Japanese trade abroad.
3. Exhibitions of export packing, methods, and materials to aid exporters in meeting requirements of foreign markets.
4. Occasional special touring trade missions, sent to foreign countries to foster interest in Japanese export products.

Principal Laws for Coordination of Production and Distribution.—What may be called the coordinating laws of the rationalization movement relate both to production and distribution and for unity and convenience may be grouped. The principal laws will be summarized as to general scope and purpose. For the most part they have been enacted on principles directly connected or in harmony with the rationalization movement. In an instance or two, legislation has preceded the actual beginning of the rationalization movement as such, but even here it may be taken not as something apart from the movement but more properly a forerunner of it.

Law for the Control of Principal Industries.—This law, enacted in 1931, is closely related to the rationalization movement, is applicable to industries designated by the Minister of Commerce and Industry, and is administered through a special committee in the Rationalization Bureau. The law aims chiefly at control of principal or key industries of the country and was drafted and presented to the Imperial Diet through the influence of the Rationalization Bureau.

The law has two main objectives, the first being to strengthen and support control measures. For this purpose the Minister of Commerce and Industry is empowered to require nonmembers of a particular industrial union to abide by control agreements of such a union, provided the action is recommended by more than two-thirds of the total members of the union in question. Unified authority of the government thus is made to reach both organized

and independent industries and to discourage individualism and possible pursuance of conflicting trade practices.

The second important function of the law is to supervise industrial control measures adopted by associations of industries. In accordance with this purpose, if the contents of a control agreement prepared by an industrial union is considered adverse to the public interest or injurious to the best interest of the industry concerned or related industries, the law empowers the competent ministers of the government to require such agreements to be changed or abolished.

To assist administration of the law, the industries concerned are required to make detailed reports to the appropriate minister on the following points: contents of agreements, organization of controls, names and business names of the industrialists concerned, location of offices and factories of industries concerned, producing equipment and capacity, and annual output of sales. A revision of the law, effected in March 1933, requires further reports on the quantity and value of monthly production and sales, and the conditions of stocks at month-ends.

The law appears to have given a distinct impetus to the cartel movement in Japan in the principal industries to which it applies.

The Industrial Association Law.—The enactment of the industrial association law, adopted in 1925, also preceded the beginning of the rationalization movement. Its chief purpose was control of industrial guilds engaged in the manufacture of important export staples and by this means elimination of wasteful competition in the purchase of raw materials and sale of products in foreign markets. It was believed that serious lack of coordination as to prices, especially among export manufacturers, was tending to impair Japan's industrial credit. The remedy was thought to be attainable through organization of guilds among manufacturers engaged in identical lines of business, control to be effected through their joint efforts.

In 1931 the law was partly modified, and the range of its application was extended to articles for home consumption. During the first 8 years after it became operative, 344 guilds were organized in Japan, and the manufactures affected amounted to 60. The following is a partial list: celluloid manufactures, glassware, porcelain, enamel utensils, bricks, lacquer ware, toys, fertilizers,

chemicals and drugs, pencils, electric bulbs, and metal goods.

Generally speaking, industrial guilds enjoy facilities for joint purchase of supplies of raw materials, coordination of production and distribution, and credit facilities for promotion of the enterprises of its members.

Law for the Control of Foreign Trade.—This law, passed by the Diet in 1934, aims to protect Japanese export trade and equalize the trade balance. Power also is invested in the government to meet foreign tariff moves against Japanese products by restricting or prohibiting imports or exports from or to any country.

Direct and Indirect Government Subsidies to Industry and Commerce.—The Japanese Government has always been highly paternalistic and has fostered and assisted the development of industry and trade to a remarkable extent. This assistance is extremely diversified but may be roughly grouped under two main headings, namely, direct subsidies, which include only the items in the budget of the Central Government for the express purpose of assisting agriculture, trade, and industry; and indirect subsidies, which include all other forms of government aid, such as low-interest government loans, export-credit guarantees, shipping subsidies, and preferential rail rates on export products.

The so-called "direct" subsidies are so highly diversified that it is difficult to obtain even an approximation of the total amount expended for this purpose.

A tabulation of subsidies and indirect government grants and assistance for a short period actually gives a very imperfect, incomplete picture of the extent of government assistance. This is particularly true of the past few years, since many important industries that formerly received large subsidies have attained full development and no longer need or receive such assistance.

Ordinarily these industries were developed to meet the demands of the domestic market and after attaining this objective have extended their operations to export trade. During the development period, they received heavy government subsidies and extensive assistance in other forms, such as low-interest loans through the official banks, technical advice and assistance, preferential treatment on all government purchases, preferential rail or water transportation rates, remission of national and local

taxes, and in a few exceptional instances government guarantees of earnings over a specified period of years. Import duties frequently were raised; occasionally, import quotas were established. To show the full extent of government assistance, it would be necessary to state the total amount expended under all these headings for at least 10 years—a practical impossibility.

General Summary of Government Subsidies.—In the annual budgets of the various departments of the Japanese Government amounts are appropriated for subsidizing agriculture, industry, and trade. The purpose of these allotments may be subdivided into three classes, namely: (1) direct foreign trade, (2) indirect foreign trade, and (3) total subsidies, all classes.

The classification of "subsidies" as given in the original Japanese text probably differs somewhat from the exact meaning of the word in English. In Japanese there are two words, "hojokin," which is translated as "assistance," "help," or "aid" (money), and "shoreikin," which means "stimulation" or "encouragement" (money). In classes 1 and 2 the text of the appropriation makes it reasonably clear that the amounts appropriated are definitely subsidies in the English meaning of the term. In some cases under class 3, the appropriations listed as "hojokin" or "shoreikin" appear to be made for purposes that are not ordinarily classified as subsidies.

Direct Foreign Trade Subsidies by the Central Government.—The actual amounts appropriated by the Central Government as direct subsidies to foreign trade are comparatively insignificant. Analysis of the departmental budgets for recent years reveals this fact.

Although the amounts are small, it may be noted that there has been a marked upward trend during recent years, reaching a peak in the fiscal year ended March 31, 1934.

Subsidy Appropriations of the Central Government Which Indirectly Benefit Foreign Trade.—A study of subsidy appropriations of the various departments of the Central Government that are believed to be indirectly beneficial to foreign trade or to export industries indicates that in every case they are directly connected with industries or commodities important in Japan's export trade.

This form of indirect assistance is so enormously diversified that it is impracticable to do more than outline the principal fea-

tures and give a few examples. Complete information with regard to the amounts expended cannot be obtained.

Government Loans to Trade and Industry.—At various times the Japanese Government has extended aid to industry and trade by means of loans, usually on extremely liberal terms and at very low rates. These loans have taken various forms. Sometimes advances have been made through the Department of Finance Deposits Bureau, which is the custodian for postal savings accounts. In other instances loans have been made through the system of "special" banks. Finally, loans have been made through the ordinary banks under government direction and with government indemnification against loss.

In general, government loans, either direct or indirect, are made only in special circumstances or to meet special emergencies. However, the aggregate of such loans in recent years has been very large, and there can be little doubt that they have been of material assistance to both industry and trade.

In 1928 the Diet passed legislation empowering the government to make loans to small traders and industrialists, utilizing for this purpose the funds held in the Deposits Bureau of the Department of Finance, the actual loans to be made by the Hypothec Bank of Japan and other "special" banks either direct or through trade associations. The maximum term of these loans was placed at 5 years. An interest rate of 3.9 per cent was charged by the Deposits Bureau, and the charges added by the issuing banks brought the rates from a minimum of 4.9 per cent on loans to associations or guilds to a maximum of 7.2 per cent on loans to individuals or firms through the local agricultural and industrial banks. All these rates are substantially below open-market rates for corresponding loans.

Government financial assistance to trade and industry is extended through a system of "special" banks, peculiar to this country. All of these banks are semiofficial, being directly under the direction and control of the government. There are now 30 of these banks: The Bank of Japan; the Yokohama Specie Bank; the Industrial Bank of Japan; the Hypothec Bank of Japan with the 25 affiliated local agricultural and industrial Banks; and the Hokkaido Colonial Bank. The Central Chest for Cooperative Societies, of which the Government is reported to own about half of the shares, might be included in this list. The Bank of

Chosen and the Bank of Taiwan have similar functions in their territories.

So far as known the government has not made any *direct* loans to individual companies but has invested substantial amounts in the South Manchuria Railway Co. and the Oriental Development Co., both of which operate a number of industrial enterprises. It has also guaranteed foreign loans of both of these organizations. The investment in the government steel works and in affiliated companies that came under government direction during the depression period following the World War has been the foundation around which the present iron and steel industry has been built. The extent of government investment and losses during the development period is unknown, but at the time of the merger with private steel producers the government works were valued at Yen 284,000,000.

Remission of National and Local Taxes.—It is customary in Japan to grant to new industries or to those considered of special importance the benefit of remission of specified national and, in some instances local taxes for a period of years. For example, rayon producers have been granted exemption from business profit and income taxes for 2 years following their organization. Similarly, manufacturers of condensed or evaporated milk are exempted from income tax for the first 3 years, besides receiving a rebate on the sugar-consumption tax paid.

As a result of legislation passed by the Diet in 1930, manufacturers of the products enumerated below are exempted from the payment of the business-profits tax (2.8 to 3.6 per cent of net profits) for 3 years following their organization:

1. Gold, silver, lead, zinc, iron or aluminum (probably refers to mining or refining of these metals).
2. Rods, bars, T shapes, angles, rails, and sheets and tubes of iron (cast-iron tubes are excepted).
3. Rods, bars, sheets, and tubes of copper alloy.
4. Engines, motors (including locomotives), machines manufactured of iron or steel and operated by motors.
5. Phosphorus, soda ash, caustic soda, lime nitrogen, ammonium phosphate, carbolic acid, chromate of potash, and glycerine.
6. Pulp for the manufacture of paper.
7. Plate glass.
8. Condensed milk.

9. Silk, linen, and woolen textiles, which are produced by power looms and have a width of more than 22.8 in. and length of more than 36 ft.

Price Preferential on Government Purchases.—One of the methods by which the government has fostered the development of domestic industry has been in connection with the system of preferential treatment on all government purchases. For a number of years the government was the largest buyer of imported products, its purchases representing a very considerable percentage of the total imports. Beginning about 1924 the government has gradually replaced these foreign purchases with domestic goods. At first the government merely specified that domestic goods be bought provided the price and quality approximately equaled that of the imported product. Later, a price preferential of up to 10 per cent was extended to domestic producers. Still later, government tenders specifically provided that only domestic manufacture of a wide variety of products be bought. Moreover, the government fostered the manufacture of a considerable number of products, which it previously purchased abroad in large quantities, by agreeing to purchase exclusively from domestic manufacturers, provided that their production followed government specifications. In other words, the domestic industry was developed to meet the government's requirements and under the stimulus of government orders. A number of industries developed in this way are becoming rather important factors in export trade.

The Export Indemnification Law.—The Export Indemnification Law was passed to foster and encourage export trade with countries where facilities for financing are inadequate or where the risks involved are abnormal.

Preferential Transportation Rates.—At various times the government has encouraged certain industries by offering preferential rates on the government railways. In most instances these rates have been extended to promote the development of a specified industry and not to stimulate exports. However, in 1930 the Department of Communications issued regulations allowing a rebate of 20 per cent of the ordinary rail freight rate between specified inland stations and ports of exportation on a wide variety of export goods. These regulations were revised and extended in October 1931, May 1932, and November 1933. In

some cases the reduced rates apply only to carload shipments and in others to less than carload lots. It is provided also that the goods must be definitely consigned for export and, in many instances, must have passed export inspection. The commodities included are raw silk, silk textiles, rayon, rayon textiles, cotton yarns, cotton textiles, straw mats, *porcelain*, lacquer ware, beer, canned foods, sugar, green tea, tangerines, apples, paper and paper manufactures, matches, straw braid, *toys*, fishing nets and cord for the manufacture of fishing nets, clocks, looms for cotton weaving, rubber boots and shoes, *phosphate*, black dye, veneer woods, matchsticks, rapeseed oil, *copper and brass wire*, *sulphur*, *arsenic acid*, *nitric acid*, *calcium carbonate*, and a variety of lumber known as "nara" (*Quercus glandulifera*).

Secret Funds in the National Budget.—The national budget carries appropriations for a number of departments under this heading. It is understood that the disbursement of these funds is entirely at the discretion of the departmental authorities, and no information is available covering the purposes for which they are used. It is believed that in the great majority of instances these appropriations are not used for subsidy or encouragement of trade and industry. However, there is no doubt that they might be utilized in this manner. It is obviously impossible to procure details in regard to the disbursement of these funds.

Disbursements of Subsidy Appropriations.—Although the subsidy appropriations appear to be highly detailed, averaging around 400 items per year, the actual disbursements are much more widely diversified. In the great majority of cases it is impossible to obtain any information covering actual expenditures, but it is possible to give an example.

During the fiscal year ended Mar. 31, 1930, the Department of Commerce and Industry expended Yen 128,000 from its subsidy for "industrial research." These funds were distributed as shown in the table on page 302.

Local Government Appropriations for Encouragement of Industry and Trade.—The budgets of the various local governments carry appropriations for encouragement and assistance to agriculture, industry, and trade. Details in regard to purposes for which these funds are used cannot be obtained, but it is reasonably certain that a very small percentage is actually used for foreign-trade promotion, although it appears probable that

a considerable amount is expended for export industries. The total of these appropriations is fairly large and undoubtedly contributes materially to the development of trade and industry.

Research Item	Amount, Yen
Sensitive photographic film	7,000
Television equipment	10,000
Manufacture of antiknock and anticorrosive naphtha	12,000
Special liquid gold	9,000
Manufacture of iron by reduction of hydrogen	7,000
Electric refrigerator	11,000
Sewing machine	10,000
Prussian blue	6,000
Bichromate of potash and soda	12,000
Anhydrous acetic acid	11,000
Saw ribbon for lumber mill	10,000
Oil engine, light	9,000
Metallic magnesium	14,000
Total	128,000

PRIVATE MEASURES FOR ENCOURAGING, ASSISTING, AND COORDINATING EXPORT ACTIVITIES

Strictly speaking, it is difficult to speak of private activities for the assistance and encouragement of trade, as government aid and assistance to export and industry generally permeate, to some extent at least, all agencies established for this purpose. This feature must be borne in mind in any consideration of this subject.

Trade Associations and Trade Guilds.—These organizations are probably the most important factors in encouraging and coordinating export activities. They are no new institution in Japan, but it is only within the past few years that they have come to exercise a vital influence in the control and exploitation of Japan's export trade.

Such associations exist for practically every important commodity exported. For export commodities, there are usually two associations, one of the manufacturers or producers and one of the exporters. Frequently a firm will both manufacture and export and will therefore belong to both associations. For practical purposes, so far as the export trade is concerned, the two associations supplement each other and cooperate in the promotion of export trade to their mutual benefit.

All associations function under government auspices. They are organized under the industrial guild law, the export guild law, or both. They are organized only with the permission of the government and under such regulations as the government may approve. This approval rests with the Bureau of Commerce and Industry, officers of which department actively assist in the organization of such associations, with an eye not only to the good of the industry concerned but of the country's trade as a whole. The government frequently takes the initiative in making compulsory the organization of an export industry. This has been done in the manufacture of lead pencils for export. These organizations are always under governmental control, passively at least, and their regulations and/or methods of operation are subject to change at all times upon government request.

So far as is known, all such associations receive some subsidy or financial assistance from the government. Such subsidies may be small. The association of pearl-bead manufacturers, for example, receives about Yen 4,000 per year; the pottery association in 1932 received a total Yen 3,900, of which Yen 3,000 was from the Central Government and Yen 450 each from the two prefectures in which the industry is centered; the association itself, during that year, expended Yen 86,864.07, so that the government contribution was but a small item in the total budget. The remainder of the association's revenues is derived from the members in membership fees, inspection fees, and other contributions. Presumably, the fact that a government grant, though small, is received, makes the government an interested party in the association and strengthens its relationship therewith.

Actually, after organizing, most associations appear to function under their own leadership and largely without government interference. However, the government may interfere at any time, or its assistance may be invoked to assist the association when need arises, whether to harmonize differences among its members, to endeavor to smooth international-trade friction, or to accomplish any other purpose.

In the various articles of association that have been read, membership does not appear to be compulsory. However, every manufacturer or exporter who desires to participate in the business must join such an association when it is organized. Moreover, such associations always have power to inspect merchandise

and refuse exportation thereof and also have other means of compelling adhesion. Therefore, whether legally or not, membership becomes in fact obligatory.

The following is a typical example of the functioning of such associations:

The Japan Pottery Exporters' Association was organized, under the auspices of the Central Government, on Jan. 26, 1933, supplanting other less important organizations previously in existence. There was considerable opposition to the organization of this association by small porcelain makers in the country districts, who feared they would be discriminated against by the larger makers, but the Government induced all makers to join.

The objects of the association, as set forth in its regulations, are:

1. To control exportation of porcelain or earthenware.
2. To inspect export goods and packing.
3. To make consignment shipments of merchandise and to export goods purchased from members.
4. To assist members in exporting their merchandise.
5. To provide cooperative equipment, which shall be at the service of all members.
6. To store, insure, grade, and pack for members (if desired).
7. To dispatch observers to foreign countries; to send goods to foreign or domestic expositions, competitive expositions, prize fairs, sample fairs; to set up the necessary machinery for the expansion of existing markets; and to investigate conditions in foreign markets.
8. To do any other work necessary to achieve the objects of the association.

Further, the regulations provide the association may:

1. Mediate for individual members.
2. Prorate among members orders received by the Association from abroad.
3. Investigate or inquire into the financial standing of foreign merchants.

The association apportions the world markets into natural divisions, with regard to the different requirements of individual markets, tariff restrictions, transportation, and financial problems that make such divisions logical. Regulations, and the form of assistance to be rendered members, as well as the general trade policy to be followed, vary with different areas.

Methods of operation vary with the different areas, as the association thinks best to cope with different conditions. In certain areas exports are pushed by means of commercial missions or exhibits; in other areas, financial assistance to exporters is given or solicited from the government.

The association has set aside certain standard items for export to the United States on which standard qualities are to be maintained, and minimum prices established. The first of such standard items to be specified were decided on Nov. 1, 1933, when eight items were so classified. The effect of such minimum prices may be gaged by the item of ovide cups and saucers, which, during 1933, sold at 40 to 45 sen per dozen; on Nov. 1 the minimum price was fixed at 58 sen, and on Jan. 1, 1934, this was advanced to 85 sen. On May 1, 1934, 22 additional items were to be added to the original 8 on which minimum prices were fixed.

The object of the preceding minimum prices is, in the case of the United States, to forestall charges of dumping. In addition, such minimum prices are expected to prevent ruthless competition of the individual makers, which has hitherto resulted in the manufacture of goods by them for sale at cost or even at a loss.

A different policy would be followed in another market, where possible competition from a domestic industry need not be considered, but even in such instances a certain amount of control is exercised to prevent overproduction and ruinous competition.

Mitsui Bussan Kaisha.—No report on private measures for encouraging, assisting, and coordinating export activities would be complete without consideration of the large industrial and trading combines whose interests are so varied and of such tremendous scope as to make them, in themselves, a most important factor in the industrial and foreign-trade scheme of Japan. These organizations are, in themselves, almost complete entities for the purpose of foreign trade and consequently are able to adopt their own practices and methods to promote not only their own, but incidentally their country's share in world trade.

The two large combinations in Japan are the Mitsui and Mitsubishi combines; the Mitsui, being the more important, will be discussed herein.

The Mitsui Gomei Kaisha (Mitsui Partnership Co.) is the central holding company for all the diversified Mitsui interests.

This is a family organization and hence can plan its policies with a degree of independence not possible in an organization that must consider the wishes and desires of partners or stockholders.

The Mitsui Gomei Kaisha owns or has controlling interests in the following enterprises:

1. Mitsui Ginko, (The Mitsui Bank).
2. Mitsui Bussan Kaisha, (Mitsui & Co., Ltd.).
3. Mitsui Kozan Kabushiki Kaisha (The Mitsui Mining Co., Ltd.).
4. Toshin Soko Kabushiki Kaisha (The Toshin Warehouse Co., Ltd.).
5. Mitsui Shintaku Kabushiki Kaisha (The Mitsui Trust Co.. Ltd.).
6. Mitsui Seimei Hoken Kabushiki Kaisha (The Mitsui Life Insurance Co., Ltd.).
7. Shibaura Seisakujo (The Shibaura Engineering Works).
8. Taisho Kaijo Kasai Hoken Kabushiki Kaisha (The Taisho Marine & Fire Insurance Co., Ltd.).
9. Nippon Seikojo (The Japan Steel Works, Ltd.).
10. Toyo Rayon Kabushiki Kaisha (The Toyo Rayon Co.).
11. Toyo Menka Kabushiki Kaisha (The Toyo Cotton Trading Co., Ltd.).
12. Kamaishi Kozan Kabushiki Kaisha (The Kamaishi Steel Co., Ltd.).
13. Nettai Sangyo Kabushiki Kaisha (The Tropical Produce Co., Ltd.).
14. Taiwan Takushoku Seicha Kabushiki Kaisha (The Formosan Development & Tea Manufacturing Co., Ltd.).
15. Hokkaido Tanko Kisen Kabushiki Kaisha (The Hokkaido Colliery & Steamship Co., Ltd.).
16. Sanshin Tatemono Kabushiki Kaisha (The Sanshin Building Co., Ltd.).

The Mitsui Bank is one of the most powerful private banks in Japan, with head offices in Tokyo and 17 branches throughout the country.

The Mitsui Bussan Kaisha is the trading agency of Mitsui, with branches in all the principal export markets of Japan; in addition to numerous other commodities, it transacts the following lines of business:

Machinery: Has agencies for many of the principal and most important articles of machinery, equipment, etc., produced throughout the world.

Coal and Oil: The largest selling organization for these commodities in Japan.

Metals and Metal Goods: The largest importer of these goods in Japan. The company is also the sole sales agent for the Imperial Government Steel Works, as well as Mitsui's own manufacturing establishments.

Fertilizers: Handles all varieties of such products. Controls the import of phosphate rock, and is the largest exporter of Japanese sulphate of ammonia.

The Mitsui Mining Co. owns and operates the Miike mine, the largest coal mine in Japan proper, as well as other important mines in Kyushu, Hokkaido, and Sakhalin. In addition to coal, the company mines iron and sulphur in important quantities and gold, silver, lead, zinc, copper and bismuth on a smaller scale. The company operates the Miike Dyestuff & Chemical Works, Miike Machinery Works, zinc refineries, and other similar enterprises.

The Mitsui Co. trains its own technical workers in the Mitsui Technical School at Omuta. This school is primarily intended to train competent foremen and technical workers who are needed for the industrialization of modern Japan. The institute also conducts research, for the firm's benefit, in mining, mechanics, electrical engineering, and applied chemistry.

It can be readily seen that this company plays a most vital part in Japan's industrial and economic structure. The company is large and powerful enough to conduct its own research, coordinate and rationalize its own activities, and develop and enlarge its own markets abroad without government assistance (though its relations with the government are usually close).

VALUE OF THE PRODUCTION OF LABOR

The lack of a definite formula with which to calculate production values on a time and labor-wage basis is a first difficulty in making estimates of labor costs in Japan. Whether the difference between the combined costs of materials and labor and the selling price should be taken as the value of labor's output, or

whether only the profit item, minus the items of overhead, factory costs, and interest on investment can be considered the true value of the labor item cannot very logically be concluded. A further consideration is that few Japanese enterprises maintain cost-accounting systems that would enable investigators to obtain data upon the cost of power, factory overhead, depreciation, and other items, and the data available are generally guarded as trade secrets; consequently statistics upon the major industries as a whole are deficient in certain essential details.

In considering labor costs and the consequent value and amount of production of Japanese workers, an important factor is the invisible labor cost for such items as the welfare service maintained by the more important industries, the system of bonuses, and the year-end and retirement allowances. It has been estimated by the Tokyo Bureau of the International Labor Office that the welfare work of the textile, steel, and chemical industries is maintained at a cost of 30 to 50 per cent of the amounts paid in actual wages. It is impossible to procure statistics upon the amounts expended for the various types of allowances, which, while customary, are never paid according to a set scale. Year-end bonuses often are as much as a month's wages; dismissal allowances may be twice or three times the monthly wage scale; and retirement allowances vary among establishments in each industry. Expenses for the foregoing items are rarely charged against the actual labor cost, being usually covered under the items of factory administration or profit.

IMPORT TRADE OF JAPAN BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934[1]

Classified group	1932	1934	Classified group	1932	1934
Metals			**Coal** (metric tons)		
Aluminum (metric tons)			Coal	2,716,127	4,060,650
Ingots, slabs, and grains	4,794	5,342	Coke	2,198	6,071
Other	3,491	4,834	**Graphite** (metric tons)	1,652	4,287
Antimony, regulus (metric tons)	2,051	2,575	**Gypsum** (metric tons)	8,077	11,894
Copper (metric tons)			**Magnesite and Dolomite** (metric tons)	68,924	114,122
Ingots and slabs	296	46,990	**Nitrate of soda** (metric tons)	23,757	39,804
Other	1,671	4,378	**Petroleum** (barrels)		
Iron ore (metric tons)	1,482,420	2,131,916	Crude and heavy oils	13,540,000	17,714,000
Pig iron (metric tons)	444,424	614,398	Mineral oil, light gasoline, gasoline, kerosene, lubricating oils	3,435,000	4,696,000
Ferroalloys (metric tons)			Lubricating greases (pounds)	550,000	1,804,000
Ferromanganese and other ferroalloys	582	134	Petrolatum (pounds)	609,000	876,000
Waste or old	559,080	1,412,988	Asphalt and bitumen (metric tons)	8,904	4,082
Lead (metric tons)			Paraffin wax, other (pounds)	51,662,000	32,801,000
Pig ingots and slabs	55,340	94,567	**Phosphate rock** (metric tons)	559,418	682,546
Tea lead	59	.....	**Potash salts** (metric tons)		
Other	554	547	Bichromate	105	78
Mercury, Quicksilver (kilograms)	340,800	498,000	Chlorate	1,019	518
Nickel (metric tons)			Chloride, crude	14,181	45,863
Ingots and grains	1,738	2,620	Cyanide of soda and potash	455	287
Other	106	18	Sulphate, crude	18,698	48,875
Platinum (kilograms)	344	1,212	**Talc and Soapstone** (metric tons)	35,481	53,626
Tin (metric tons)					
Ingots and slabs	3,437	4,054			
Other	12	8			
Zinc (metric tons)					
Ore	35,544	13,079			
Spelter, ingots, slabs, and grains	20,905	26,579			
Plates, sheets, and other zinc	5,667	6,629			
Nonmetals					
Asbestos, (unmanufactured (metric tons)	7,623	20,515			

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

PRODUCTION IN NORWAY OF 32 MAJOR INDUSTRIAL MINERALS
(In Metric Tons)

Commodities	1932	1933	1934	Per cent of total world[1]
Metals:				
Aluminum	17,800	15,400	15,300	8.9
Antimony	.....	.....	.....	
Bauxite	.....	.....	.....	
Chromite	409	326	42	
Copper[2]	16,944	19,879	21,122	1.6
Iron ore	373,907	473,863	567,414	
Pig iron	103,092	112,653	126,932	
Lead[2]	858	830	500	
Manganese	.....	.....	.....	
Mercury (flasks)	.....	.....	.....	
Nickel[2]	975	969	1,334	1.8
Platinum (troy ozs.)	.....	.....	.....	
Tin[2]	.....	.....	.....	
Tungsten	.....	.....	.....	
Vanadium	.....	.....	.....	
Zinc[2]	8,874	9,251	6,394	
Nonmetals:				
Asbestos	.....	.....	.....	
Barite	.....	.....	.....	
China clay	.....	.....	.....	
Coal	.....	.....	.....	
Fluorspar	571	507	673	
Graphite	672	1,983	2,281	[3]
Gypsum	.....	.....	.....	
Magnesite	1,311	2,007	2,500	
Mica[4]	103	105	170	[3]
Natural nitrates	.....	.....	.....	
Petroleum, crude (bbls.)	.....	.....	.....	
Phosphate	.....	.....	.....	
Potash: Equivalent K_2O	.....	.....	.....	
Pyrites	727,020	864,576	960,898	[3]
Sulphur	[5]	[5]	[5]	
Talc and soapstone	13,536	19,885	34,474	[3]

[1] Calculated on basis of 1934 production; items representing less than one-half of 1 per cent not calculated.
[2] Mine production in terms of metal content.
[3] Not susceptible of calculation.
[4] Exports.
[5] Data not available.

NORWAY

The mining industry of Norway is assisted through the services of various branches of the Department of Commerce. The Geological Survey, consisting of a small permanent staff of geologists, provides the customary services of an organization of this type. The assistance rendered by the Geological Survey is supplemented by that of the Norwegian Geological Society of Oslo, founded in 1905. The society is subsidized to some extent by the government. The Central Statistical Board collects, compiles, and publishes annual statistics on mineral production and trade of Norway.

The Norwegian agreements with foreign countries, taking the form of commercial treaties that regulate the purchase of coal, represent the most important government or industrial factor that has influenced Norway's international trade in mineral commodities in recent years (B. Livingston, American Vice-Consul, Oslo, Norway).

By the commercial treaty with Great Britain, entered into on Aug. 1, 1933, Norway agreed to purchase 70 per cent of its coal from that country. In a supplemental agreement to the Polish-Norwegian commercial treaty of 1926, signed in January 1935, Poland was assured of Norwegian import licenses for not less than 200,000 tons of Polish coal per annum. In 1934 Norway imported 2,066,268 tons of coal. Had the Polish-Norwegian agreement been in effect only slightly more than 400,000 tons could have been purchased from other countries. As it happened, Great Britain did not ship its entire quota, but Poland exceeded its quota under the 1935 agreement by over 100 per cent.

Norway has commercial agreements with various other countries, but these do not specifically refer to mineral raw materials.

On June 28, 1934, the Norwegian Storting authorized the government to guarantee up to Kr. 500,000 a proposed loan to A/S Norsk Staal, Oslo, to be used for the construction near Kristiansand of a plant for the industrial production of sponge

iron under the *Bochum* process. This authorization may be considered an indirect factor affecting the flow of minerals.

Private Agreements.—It has been impossible to ascertain with much accuracy the industrial and trade agreements or arrangements that have been consummated to control or regulate the output of, and markets for, mineral raw materials. It is known that the Norsk Aluminum Co., A/S, is controlled by the Aluminum Co. of America. Norwegian nickel interests are either independent or connected with International Nickel Co. and operate on a quota basis. It is difficult to determine the exact control exercised over the individual firms.

Petroleum imports into Norway are under the control of certain large organizations, and although operations are carried on by so-called subsidiary companies these are in reality but branches of the large international organizations.

It is known that other minerals produced in Norway are subject to the control of European cartels, but accurate information cannot be obtained. The principal restrictive influence arises from the connection between certain Norwegian mining interests and Swedish concerns, but these are interfirm agreements and are not entirely within the scope of this survey.

IMPORT TRADE OF NORWAY BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934[1]

Classified group	1932	1934	Classified group	1932	1934
Metals			**Nonmetals**		
Aluminum (metric tons)			Asbestos (metric tons)	784	771
Bauxite	19,420	29,956	China clay (metric tons)	17,933	21,515
Crude	1,735	185	Coal (metric tons)		
Alumina	23,619	20,377	Coal	2,044,247	2,125,704
Bars, sheets, tubes, etc	67	84	Coke	376,179	375,990
Antimony (metric tons)	46	42	Fluorspar (metric tons)	446	732
Chrome ore (metric tons)	11,052	37,365	Graphite, crucibles, etc. (metric tons)	42	69
Copper (metric tons)			Gypsum, crude and calcined (metric tons)	9,703	11,753
Copper and bronze sheets, plates, rods, and other	1,141	1,424	Magnesite, calcined (metric tons)	481	565
Copper brass, etc., rough	576	431	Nitrate of soda (metric tons)	39	21
Iron ore (metric tons)	1,918	1,548	Petroleum (barrels)		
Pig iron (metric tons)	9,906	12,020	Crude oil	192,000	261,000
Ferroalloys, ferrosilicon, ferro-tungsten, and ferrovanadium (metric tons)	11	62	Gasoline	999,000	917,000
			Kerosene	278,000	276,000
			Lubricating oil	69,000	76,000
			Gas oil and fuel oil	1,335,000	2,108,000
			Fuel oil, residue	(Not avail.)	72,000
Lead (metric tons)					
Pig	1,907	3,216			
Sheets, tubes, and wire	651	667	Petrolatum and axle grease (pounds)	1,122,000	1,380,000
Manganese ore (metric tons)	20,055	108,555	Paraffin wax and stearic acid (pounds)	1,768,000	2,149,000
Mercury, Quicksilver (kilograms)	(Not avail.)	41,386	Phosphate (metric tons)		
Nickel, copper-nickel matte (metric tons)	4,398	8,509	Phosphate rock	11,758	19,455
Platinum, sheets, rolled, and wire (kilograms)	1.0	31.5	Superphosphates	28,664	30,919
			Basic slag	8,068	3,474
Tin (metric tons)			Potash (metric tons)		
Pig	315	377	Fertiliser salts	19,634	20,804
Rolls, bars, sheets, plates, and filings	111	123	Carbonate	440	543
			Caustic	1,353	1,752
			Chloride	114	148
			Nitrate	96	146
Zinc (metric tons)			Pyrites, sulphur (metric tons)	.....	202
Ore	77,179	79,731	Sulphur, including flowers of (metric tons)	11,317	11,172
Crude, spelter	345	830			
Bars and sheets	1,451	1,772			
Ashes and scrap	284	150			
Lithopone	123	186			

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

PRODUCTION IN SPAIN OF 32 MAJOR INDUSTRIAL MINERALS
(In Metric Tons)

Commodities	1932	1933	1934	Per cent of total world
Metals:				
Aluminum	1,200	1,200	1,200	
Antimony	.....	.....	.....	
Bauxite	1,300	2,500	.....	
Chromite	.....	.....	.....	
Copper[2]	35,000	44,000	30,000	2.3
Iron ore	1,760,471	1,815,484	2,094,001	1.7
Pig iron and ferroalloys	300,617	338,853	372,366	
Lead[2]	100,000	75,100	66,400	4.9
Manganese	2,591	2,834	3,796	
Mercury (flasks)	23,656	19,626	31,799	47.6
Nickel	.....	.....	.....	
Platinum (troy oz.)	.....	.....	.....	
Tin	.....	.....	.....	
Tungsten[3]	43	46	49	
Vanadium	.....	.....	.....	
Zinc[2]	35,200	35,400	31,600	2.2
Nonmetals:				
Asbestos	.....	.....	.....	
Barite	8,934	4,605	17,528	
China clay[4]	1,170	1,570	1,370	
Coal: Anthracite and bituminous	6,854,000	5,999,000	5,932,000	
Lignite	336,000	301,000	299,000	
Fluorspar	7,018	3,564	6,365	[9]
Graphite	.....	.....	.....	
Gypsum	697,230	709,246	741,245	9.5
Magnesite	.....	.....	.....	
Mica	.....	.....	.....	
Natural nitrates	750[5]	1,016[5]	[6]	
Petroleum, crude (bbl.)	[6]	[6]	[6]	
Phosphate rock	9,980	14,507	19,297	
Potash[7] Equivalent K_2O	54,811	90,637	121,002	5.5
Pyrites	2,146,441	2,223,472	2,072,413	[9]
Sulphur[8]	8,243	27,614	31,629	[9]
Talc and soapstone	6,574	10,064	5,285	[9]

[1] Calculated on basis of 1934 production; items representing less than one-half of 1 per cent not calculated.

[2] Mine production in terms of metal content.

[3] Concentrates containing 60 per cent WO_3.

[4] The following quantities of kaolinic sand were also produced: 1932, 3,940 cu. m.; 1934, 4,540 cu. m.

[5] Nitrified earth.

[6] Data not available.

[7] Exclusive of K_2O equivalent of following quantities of potassic earth; 1932, 750 tons; 1933, 500 tons; 1934, 500 tons.

[8] Refined sulphur, exclusive of that made from imported crude sulphur.

[9] Not susceptible of calculation.

SPAIN[1]

Considered from the angle of output and the diversification of industries, Spain has not made the advance as an industrial nation that is evident in most of the other countries covered by this survey. However, as Spain is the leading producer of mercury and is likewise important as a source of supply of pyrites, iron ore, and lead, it must be considered in this report as an important source of supply rather than an outstanding industrial consumer of mineral raw materials. The government, through the Bureau of Mines and Fuels, assists and to some extent regulates the mining industry. Subordinate to the Bureau of Mines are the council of Mining, the Geological and Mining Institute of Spain, the Office for Regulating and Combining the Exploitation of Potash Salts, the Special School for Mining Engineers, and the Chemical and Metallographic Laboratories. The Bureau of Mines and Fuels is responsible for conducting geological studies and mineral investigations, mining concessions, collection of mining taxes, collection and publication of mineral statistics and pertinent economic information, inspection of mines, maintenance of the School of Mines, and the administration of State mines. The Bureau of Mines issues a monthly publication entitled, "Boletin Oficial de Minas, Metalurgia y Combustibles" (Official Bulletin of Mines, Metallurgy, and Fuels), and an annual statistical summary entitled, "Estadistica Minera y Metalurgica de España" (Statistics of Mines and Smelters of Spain). An outstanding feature of the mining industry of Spain is the state control of the mercury mines of Almaden, the lead mines of Arrayanes, and the salt mines of Torrevieja and Mata. To regulate and operate these State mines, the Council of Administration of the Mines of Almaden and Arrayanes was organized by royal decree in December 1923. This autonomous council functions under the supervision of the Minister of the Interior, and its duties include the administration of state-owned mining

[1] Enciclopedia Universal Ilustrada, 1917, vol. 35, pp. 353–376; Apendice, 1932, vol. 7, pp. 490–499.

IMPORT TRADE OF SPAIN BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934[1]

Classified group	1932	1934
Metals		
Aluminum (metric tons)		
Alumina	3,901	3,996
Ingots and scrap	11	12
Bars and tubes	25	50
Sheets	7	15
Wire	.....	3
Sulphates	151	187
Antimony (metric tons)		
Regulus	3	2
Sulphide	53	28
Copper (metric tons)		
Precipitate and scrap, including alloys	3,764	3,717
Ingots, including alloys	172	105
Copper, bronze or brass bars, thickness in smallest section not exceeding 1 cm	57	83
Wire of copper, bronze, or brass	103	147
Wire cables of copper, bronze or brass	20	32
Plates and sheets of copper and its alloys, not polished	94	103
Tubes or pipes, not polished	41	43
Iron ore (metric tons)	3,302	12,353
Pig iron (metric tons)	1,005	954
Ferroalloys (metric tons)		
Ferromanganese, ferrosilicon, and other alloys	315	316
Old and scrap, cast and malleable iron and steel	127,193	106,552
Lead (metric tons)		
Galena, nonargentiferous	2,755	(Not avail.)
Other lead ores	4,951	174
Pig and scrap	175	121
Pipes and sheets	4	22
Wire	4	4
Manganese ore, 20% content and above (metric tons)	5,141	17,124
Mercury, Quicksilver (kilograms)	100	.....
Nickel (metric tons)		
Ingots and cubes	311	265
Sheets, tubes, wire, and alloys	61	83
Platinum (hectograms)		
Unwrought, bars, lumps, dust, and ingots	300	122
Manufactured wire, sheets, small rods, varillas, tubes, and bars	299	11
Tin (metric tons)		
Ingots and bars	1,753	1,612
Sheets and tubes	12	12
Foil	13	4
Zinc (metric tons)		
Blende	610	
Spelter and scrap	1,127	1,706
Plates, nails, and wire	39	65
Nonmetals		
Asbestos (metric tons)		
Unmanufactured	4,132	4,702
Spun and woven	72	93
China clay (metric tons)	14,997	19,844
Coal (metric tons)		
Anthracite	82,988	78,309
Bituminous	736,952	946,656
Other coal	129	55
Coke	81,362	82,199
Briquets	16,187	17,389
Mica, sheets (metric tons)	9	18
Nitrate of soda, Chilean (metric tons)	67,758	155,848

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

IMPORT TRADE OF SPAIN BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934.[1]—(*Continued*)

Classified group	1932	1934
Petroleum (barrels)		
Crude	157,000	143,000
Gasoline	3,275,000	3,740,000
Kerosene	165,000	124,000
Lubricating oils	229,000	217,000
Diesel oil	561,000	(Not avail.)
Gas oil	(Not avail.)	893,000
Fuel oil	1,250,000	1,522,000
Paraffin wax (pounds)	10,423,000	11,674,000
Petrolatum (pounds)	407,000	2,972,000
Petrolatum oil (pounds)	3,782,000	[2]
Petrolatum, pitch and asphalt (metric tons)	46,882	65,152
Phosphates (metric tons)		
Phosphate rock	563,375	564,375
Superphosphates	136	503
Basic slag	4,547	3,274
Potash salts (metric tons)		
Fertiliser salts	7,652	7,312
Carbonate	179	184
Caustic and soda	333	401
Chlorate	21	3
Permanganate	12	16
Pyrites, copper ore and cupreous pyrites containing more than 2.5% copper (metric tons)	1	.....
Sulphur (metric tons)		
Crude, unground	9,877	15
Refined, unground	77	.....
Refined, ground and flowers of	182	672

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

[2] Included in petrolatum.

properties, with particular respect to mine practices and procedure, labor, sale and transportation of the mineral products, price scales, agreements with other domestic and foreign producers, and the issuance of annual financial reports.

PRODUCTION IN SWEDEN OF 32 MAJOR INDUSTRIAL MINERALS
(In Metric Tons)

Commodities	1932	1933	1934	Per cent of total world[1]
Metals:				
Aluminum	.....	.....	300[2]	
Antimony	.....	.....	.....	
Bauxite	.....	.....	.....	
Chromite	.....	.....	.....	
Copper[3]	4,309	6,871	5,099	
Iron ore	3,298,989	2,698,750	5,253,058	4.3
Pig iron	282,163	345,526	558,129	1.0
Lead[3]	7,308	7,520	8,248	
Manganese	3,014	5,895	5,832	
Mercury (flasks)	.....	.....	.....	
Nickel	.....	.....	.....	
Platinum (troy oz.)	.....	.....	.....	
Tin	.....	.....	.....	
Tungsten	.....	.....	.....	
Vanadium	.....	.....	.....	
Zinc[3]	24,544	24,737	29,121	2.0
Nonmetals:				
Asbestos	.....	.....	.....	
Barite	.....	.....	.....	
China clay	1,411	1,908	2,374	
Coal	333,076	348,921	415,226	
Fluorspar	.....	.....	.....	
Graphite	.....	.....	.....	
Gypsum	115	49	121	
Magnesite	.....	.....	.....	
Mica	61	68	16	[4]
Natural Nitrates	.....	.....	.....	
Petroleum, crude (bbl.)	.....	.....	.....	
Phosphate	.....	.....	.....	
Potash: Equivalent K_2O	.....	.....	.....	
Pyrites	71,534	86,295	100,572	[4]
Sulphur	.....	634	505	
Talc and soapstone	4,525	4,396	6,501	[4]

[1] Calculated on basis of 1934 production; items representing less than one-half of 1 per cent not calculated.
[2] May include production of minor producing countries of Europe.
[3] Mine production in terms of metal content.
[4] Not susceptible of calculation.

SWEDEN[1]

Sweden is included in this survey because it is becoming increasingly important as a manufacturing nation and, consequently, a consumer of industrial minerals. In addition, Sweden is important potentially for entrepot trade. The accompanying import statistical table shows notable increases of such raw materials as bauxite, chrome ore, copper ingots, pig iron, and pyrites during the 3-year period covered. Iron ore is the outstanding mineral produced in Sweden, but the increase in imports of those other raw materials essential to the iron and steel and allied industries indicates the extent of industrialization effected by Sweden in recent years.

The Geological Survey of Sweden, a branch of the Department of Agriculture, conducts basic mineral research. In addition to the survey, the mining industry of Sweden is aided by the Bureau of Mines, Department of Commerce. The latter organization is responsible for safety inspections of mines, observance of labor laws, publication of mine maps, and collection and dissemination of mineral statistical and other economic information.

[1] Nordisk Familjebok Encyklopedi, Stockholm, 1925.

IMPORT TRADE OF SWEDEN BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934[1]

Classified group	1932	1934
Metals		
Aluminum (metric tons)		
Bauxite	8,267	18,397[2]
Crude	1,363	2,369
Sheets and stripe, rolled or pressed	289	448
Antimony[3]		
Chrome ore (metric tons)	9,534	35,552
Copper (metric tons)		
Ore	898	2,418
Crude ingots	19,659	31,862
Plates, sheets, and other shapes	177	223
Wire	256	318
Scrap, copper, and brass	354	736
Iron ore (metric tons)	.....	38
Pig iron (metric tons)	38,731	80,657
Ferroalloys (metric tons)		
Ferromanganese and other ferro-alloys	3,624	10,000
Granulated cast iron	383	436
Old and scrap	864	730
Lead (metric tons)		
Pig	10,316	13,985
Plates, sheets, and pipes	1,604	2,389
Scrap	5	22
Manganese ore[4]		
Mercury, Quicksilver (kilograms)	22,278	30,996
Nickel, crude (metric tons)	445	982
Platinum, crude bars and scrap (grams)	107	3,704
Tin, crude and scrap (metric tons)	1,214	1,760
Zinc (metric tons)		
Crude, slabs	8,211	12,704
Sheets and bands	1,561	2,197
Scrap	175	118
Lithopone	1,925	2,428
Nonmetals		
Asbestos, unmanufactured (metric tons)	1,193	1,703
Barites, witherites (metric tons)	1,090	1,335
China clay, refractory (metric tons)	24,342	30,388
Coal (metric tons)		
Anthracite	76,412	85,636
Bituminous	4,452,703	5,178,927
Coke	1,297,049	1,482,632
Briquets	7,644	6,594
Graphite (metric tons)	445	537
Gypsum (metric tons)		
Crude	13,235	20,673
Calcined	5,560	5,548
Magnesite, crude and calcined (metric tons)	1,222	1,798
Nitrate of soda (metric tons)	18,863	35,704
Petroleum (barrels)		
Crude	232,000	438,000
Gasoline	2,857,000	3,018,000
Kerosene	605,000	745,000
Lubricating oil	339,000	339,000
Gas and fuel oil	1,557,000	1,761,000
Lubricating grease (pounds)	6,337,000	8,387,000
Paraffin wax (pounds)	7,737,000	7,750,000
Asphalt (metric tons)	6,650	5,529
Petroleum pitch (metric tons)	11,312	15,667
Phosphates (metric tons)		
Phosphate rock	82,528	108,344
Superphosphates	7,463	7,843
Basic slag	346	54
Potash salts (metric tons)		
Fertilizer salts	65,225	83,105
Carbonate	1,273	1,572
Caustic	2,747	3,717
Chlorate	4	6
Chloride	4,137	7,328
Nitrate	463	441
Pyrites, iron containing sulphur (metric tons)	121,612	188,352
Sulphur (metric tons)	60,068	82,684

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

[2] Combined with flint, fluorspar, silicon, and cryolite.

[3] Not separately reported.

[4] Tonnage and value not separately provided for.

PRODUCTION IN U.S.S.R. (RUSSIA) OF 32 MAJOR INDUSTRIAL MINERALS
(In metric tons)

Commodities	1932	1933	1934	Per cent of total world[1]
Metals:				
Aluminum	1,000	4,400	14,400	8.4
Antimony	[2]	[2]	[2]	
Bauxite	37,400	50,600	61,000	4.6
Chromite	68,000[3]	112,728	129,200	20.8
Copper[4]	32,000	32,700	44,100	3.4
Iron ore	12,200,000	14,500,000	21,700,000	18.0
Pig iron	6,173,000	7,133,000	10,400,000	16.6
Lead[5]	18,800	13,700	27,000	2.0
Manganese	915,300	998,000	1,821,000	63.6
Mercury (flasks)	[2]	[2]	[2]	
Nickel[4]	.....	.....	863	1.2
Platinum, placer (troy oz.)	100,000[3]	100,000[3]	100,000[3]	[6]
Tin	[2]	[2]	[2]	
Tungsten	[2]	[2]	[2]	
Vanadium	[2]	[2]	[2]	
Zinc[4]	17,300	21,900	31,800	2.2
Nonmetals:				
Asbestos	60,000	74,000	[2]	[6]
Barite	[2]	[2]	[2]	
China clay	[2]	[2]	[2]	
Coal[7]	64,000,000	76,700,000	92,031,000	7.2
Fluorspar	[2]	[2]	[2]	
Graphite	[2]	[2]	[2]	
Gypsum	[2]	[2]	[2]	
Magnesite	334,454	380,300	482,000	[6]
Mica	7,790	5,778	[2]	[6]
Natural nitrates	[2]	[2]	[2]	
Petroleum, crude (bbl.)[7]	155,737,000	156,166,000	175,950,000	11.5
Phosphate rock	387,000	687,000	[2]	[6]
Potash: Equivalent K_2O	[2]	42,122	139,197	6.3
Pyrites	[2]	378,200	381,900	[6]
Sulphur	[2]	[2]	[2]	
Talc and soapstone	[2]	[2]	[2]	

[1] Calculated on basis of 1934 production; items representing less than one-half of 1 per cent not calculated.
[2] Data not available.
[3] Approximate production.
[4] Mine production in terms of metal content.
[5] Smelter output.
[6] Not susceptible of calculation.
[7] Includes Russian Sakhalin.

U.S.S.R. (RUSSIA)[1]

State Planning System.—State planning in the Union of Socialist Soviet Republics is an integral part of the national economy. Socialization of the means of production and distribution—land, minerals, and other natural resources; banks; transportation; industrial and commercial enterprises—constitutes the basis for the national planning system. Its aim is to employ to the fullest extent and in the most effective manner the available natural resources and means of production.

In 1921 a central planning organization, the State Planning Commission (Gosplan), was organized. At first its programs covered only individual branches of industry, but, with stabilization of the currency and the development of state industry and the cooperative system, annual plans or "control figures," beginning with the fiscal year 1925–1926, were drawn up for the entire national economy.

Soviet economic plans are prepared on the basis of general instructions issued by Gosplan. The specific data, however, are collected by the combined efforts of all economic organizations. The economic commissariats of the Union and of the constituent republics, the various economic agencies (local and national), the banks, the cooperatives, the industrial enterprises, the trade unions, the local soviets, the educational and scientific institutes, the state and collective farms—all participate in the collection of data for and the preliminary drafting of the respective parts of the nation-wide social-economic plan. All the specific data collected and partial plans submitted by the various organizations are then elaborated by Gosplan and coordinated into a unified plan of economic administration. On the basis of this unified plan the higher planning bodies assign each factory, mill, mine, and state farm a specific schedule that covers all phases of activity of the enterprise—amount and quality of output, production costs, labor productivity, and working and living conditions.

[1] Handbook of the Soviet Union, by the American-Russian Chamber of Commerce.

The annual plans or control figures cover all branches of national economy for 1 year in advance. Each year they have assumed a more integrated and comprehensive character, embracing distribution as well as production. However, expansion of the national economy as a whole made necessary longer range planning as well. Complicated projects for power plants, factories, mills, and State and collective farms, requiring several years for their execution, could not be covered by the control schedule covering 1 year only. It was, consequently, decided to draft a comprehensive 5-year plan. The first Five-year Plan was adopted in 1929. It was originally drawn to cover the 5 years from Oct. 1, 1928, to Sept. 30, 1933, but later the period covered by the plan was decreased to terminate at the end of 1932.

The stated aim of the First Five-year Plan was to lay the basis for transforming a backward agricultural country into a highly industrial nation capable of satisfying the rapidly growing demands of its population for agricultural and manufactured products. This involved the reequipment of old plants and the construction of many new ones, the creation of new industries, the opening up of new economic regions, and the socialization and mechanization of agriculture. In carrying out the policy of industrialization the main emphasis was placed upon the development of heavy industry and electrification as the basis for the building up of both light industry and agriculture.

The stated aims of the Second Five-year Plan, while continuing the development of heavy industry, are to expand considerably the output of consumers' goods to advance the standard of living. In the first Five-year Plan period several large industrial combines, such as the Ural-Kuznetsk, were initiated, but the building of large individual enterprises was considered of more immediate necessity. During the second 5-year period, development of the Dneper and Ural-Kuznetsk combines is being pushed; and new enterprises, such as the Greater Volga and the Lake Balkhash copper-combine projects, are to be carried out.

First Five-year Plan.—Some of the most important progress made was in the field of heavy industry incident to the original Five-year Plan. Among the supplemental works of the 4-year period (1928–1932) are: (1) A second coal and metallurgical base was created in the East—the Ural-Kuznetsk combine. This

combine embraces not only the new huge steel mills at Magnitogorsk and Stalinsk (formerly Kuznetsk), but a whole network of new enterprises to produce coal, coke, locomotives, copper, heavy machinery (Sverdlovsk), tractors (Chelyabinsk), chemicals (Berezniky), potash (Solikamsk), and other commodities. This new industrial center, with its available resources of iron, coal, nonferrous metals, and other minerals, is expected to be a very important factor in the program of economic development in the coming years. (2) Various technical problems have been solved, such as (*a*) production of aluminum and synthetic rubber, ferroalloys and various types of special steel, and vanadium from Kerch and Ural ores; and (*b*) utilization of low-grade fuel on a large scale for power and industrial plants.

Problems that hitherto hindered economic development have included the lagging of the iron and steel and nonferrous metals industries and the insufficient emphasis given in the past years to the opening up of new coal and oil basins, particularly in the outlying regions.

The inadequate supply of trained engineers, technicians, mechanics, and workers experienced in the operation of modern machinery has hampered efficient operation of the many new plants equipped with the most up-to-date machinery. At present major emphasis is being placed upon perfecting the technical details of production and improving efficiency of operation.

First Two Years of the Second Five-year Plan (1933–1937).—Industry made increases in practically all fields in 1933. The output of coal and pig iron gained 18.4 and 15.6 per cent, respectively, the machinery and metalworking industries 14.2 per cent, and power 18.4 per cent over that in 1932. The production of oil and nonferrous metals declined slightly.

An outstanding feature of 1934 compared with 1933 was the growth of the metallurgical industry. Pig-iron output totaled 10.4 million tons, an increase of 46 per cent; steel production, at 9.6 million tons, increased by 40 per cent, and rolled products by 39 per cent. For the 2-year period 1933–34 the rates of growth of pig iron and steel reached the figures of 68 and 62 per cent, respectively.

Coal production, totaling 92 million tons, increased over 20 per cent. In the first 2 years of the Second Five-year Plan the increase was approximately 45 per cent. The nonferrous-metal,

chemical, and many other industries also increased their output.

A great amount of capital construction was completed in 1933–1934. Many new enterprises were put into operation during the 2 years, including such important projects as the Ural and Kramatorsk heavy machinery plants, the Lugansk locomotive plant, the Chelyabinsk tractor factory, the Zaporozhe tool-steel and ferroalloys plants, the Azov and Lipetsk steel mills, the Dneper aluminum works, 69 coal mines with a capacity of 34 million tons, the Stalinogorsk (Bobriky) and Voskresensk chemical plants, the Solikamsk potash works, over 12 major power plants (or extensions to existing stations), 6 large packing houses, 14 canneries, and 3 sugar refineries.

Place of the U.S.S.R. (Russia) in World Economy.—As a result of the advance of Soviet economy during the First Five-year Plan and of the economic depression in other countries, the U.S.S.R., according to Soviet authorities, rose in rank as regards industrial output from fifth to second place, and its share in the total world output increased from 4.9 per cent in 1928 to 17.5 per cent in 1932. For oil, pig iron, and industrial machinery it holds first place in Europe and is second in world production only to the United States.

The U.S.S.R. holds the first place in peat production and has gained a leading position as regards coal and oil. With respect to coal production, the U.S.S.R. rose from sixth place in 1928 to fourth in 1934, following the United States, Great Britain, and Germany. In 1931 the Soviet Union reached second place in oil production, supplanting Venezuela. Its production surpassed that in Venezuela by over one-third, both in 1931 and 1932. Whereas in 1928 the United States output of coal was fifteen times and of oil eleven times that of the U.S.S.R., in 1932 it was only about five times that of both coal and oil.

In 1934 the Soviet Union occupied second place in the world with respect to the output of pig iron and third place in the output of steel. This contrasts with the situation in 1928, when it held sixth place for pig iron and fifth for steel and when output in Great Britain was over twice, in France and Germany more than three times, and in the United States nearly twelves times Soviet production.

The exports of the Soviet Union have consisted principally of raw materials, industrial and agricultural, for some of which it ranks high in world trade. It holds first place as an exporter of timber and manganese, supplying over half the world total of the latter, and is a leading exporter of furs, fish, oil, and wheat.

Although the Soviet Union occupies an advanced position as regards volume of industrial production, it lags behind the other leading industrial countries in certain other respects, such as technical efficiency, labor productivity, quality of output, and norm of production per capita.

Organization of Industry.—All large-scale industry in the U.S.S.R. is state-owned or operated by cooperative organizations. The state industries, which account for over 85 per cent of the total industrial output of the country and include all of the important enterprises, are under supervision of the four industrial commissariats (Heavy Industry, Light Industry, Food Industry, and Timber Industry) and the Procurements Committee of the Council of People's Commissars (mainly flour-milling plants). On Jan. 1, 1933, there were in the U.S.S.R. 23,508 large-scale enterprises (exclusive of the lumber industry and fisheries), of which 12,283 turned out producers' goods and 11,225 consumers' goods. Of the total number of enterprises, 720 formed part of the fuel industry, 3,449 the metallurgical and machine industries, 964 mining and mineral industries, 890 chemical industry, 2,456 building materials, 1,349 textiles, and 4,995 the food industry. Sixty-eight per cent of the industries (producing 74 per cent of the output) were in the Russian Socialist Federal Soviet Republic, 21 per cent (accounting for 18 per cent of the production) were in the Ukraine, and the remainder were scattered among the other republics. There are also many thousands of small industrial enterprises, not included in the above enumeration, operated mainly by producers' cooperatives and collectives. Small-scale (noncensus) industries account for about 8 per cent of the total industrial output.

The four industrial commissariats are subdivided into a number of administrations, each of which supervises a particular branch of industry or some special functional activity. For instance, there are 33 chief administrations in the Commissariat for Heavy Industry, including such organizations as *Gutap*—

Chief Administration of the Tractor and Automobile Industry; *Glavmashprom*—machine-building industry; *Glavneft*—oil industry; *Glavugol*—coal industry; and *Glavenergo*—power industry. There are also chief administrations which supervise the supplying of food and other commodities to industrial enterprises (*Gurs*), and the lower and technical schools under the control of the Commissariat (*Guuz*).

The remaining commissariats are divided similarly. The Commissariat for the Timber Industry, for instance, combines 11 chief administrations, among them *Glavlescexport*—in charge of lumber exports; *Glavbumprom*—paper industry; and *Glavspichprom*—match industry. The chief administrations exercise general supervision over the operations of the trusts (combinations of enterprises in a given industry, covering either a particular territory or, in some instances, the entire country). The individual enterprises, in turn, are subordinated to the trusts. Many of the largest enterprises, however, are directly subordinated to the chief administrations.

IMPORT TRADE OF THE U.S.S.R. (RUSSIA) BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934[1]

Classified group	1932	1934
Metals		
Aluminum, block, scrap, and sheets (metric tons)	10,603	5,091
Antimony, regulus and oxide (metric tons)	748	1,280
Copper, ingots, sheets, etc. (metric tons)	11,970	11,487
Pig iron, ingots and blooms (metric tons)	2,120	1,841
Ferroalloys (metric tons)		
Ferrochrome, manganese, molybdenum, silicon, tungsten, vanadium, and titanium	13,017	10,713
Old and scrap	2,095	
Lead, pig, scrap, and alloys (metric tons)	33,778	18,731
Mercury, Quicksilver (metric tons)	1	0.1
Nickel, bars, alloys, castings, slabs, and pigs (metric tons)	3,959	4,260
Tin, blocks, pigs, rods, and scrap (metric tons)	3,910	5,898
Tungsten, wolfram (metric tons)	.....	839
Zinc (metric tons)	10,607	4,317
Nonmetals		
Asbestos, powder, lumps and blocks, sheets, filter paper strips, for insulation, and packing (metric tons)	273	112
Barium minerals, barite, witherite, and salts (metric tons)	13	.....
Coal (metric tons)		
Anthracite	52,511	26,425
Coke and briquets	.....	37
Graphite, ground (metric tons)	1,229	.....
Mica (metric tons)	38	.....
Potash, nitrate (metric tons)	2,166	.....
Sulphur (metric tons)	3,012	4,233
Talc (metric tons)	11	.....

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

PRODUCTION IN UNITED KINGDOM OF 32 MAJOR INDUSTRIAL MINERALS
(In Metric Tons)

Commodities	1932	1933	1934	Per cent of total world[1]
Metals:				
Aluminum	10,200	11,000	12,900	7.5
Antimony				
Bauxite[2]	1,497	709	58	
Chromite				
Copper[3]	62	41	14	
Iron ore[4]	7,445,807	7,581,481	10,756,765	8.9
Pig iron and ferroalloys	3,631,363	4,202,383	6,074,455	9.7
Lead[3]	33,441	40,375	54,680	4.0
Manganese				
Mercury				
Nickel				
Platinum (troy oz.)				
Tin[3]	1,358	1,567	2,031	1.6
Tungsten[5]	2	12	223	1.4
Vanadium				
Zinc[3]	4	4	452	
Nonmetals:				
Asbestos				
Barite	57,548	67,689	75,182	[6]
China clay	517,017	606,185	701,206	[6]
Coal	212,083,000	210,436,000	224,270,000	17.5
Fluorspar	15,675	28,508	34,765	[6]
Graphite				
Gypsum	1,011,440	1,000,865	977,014	12.5
Magnesite				
Mica				
Natural nitrates				
Petroleum, crude (bbl.)	705	306	345[7]	
Phosphate rock				
Potash: Equivalent K_2O				
Pyrites	1,008	1,150	2,179	
Sulphur				
Talc and soapstone	262	169		

[1] Calculated on basis of 1934 production; items representing less than one-half of 1 per cent not calculated.
[2] Northern Ireland.
[3] Mine production in terms of metal content.
[4] Exclusive of bog ore used mainly for purification of gas.
[5] Concentrates containing 60 per cent WO_3.
[6] Not susceptible of calculation.
[7] Estimated.

UNITED KINGDOM

The United Kingdom depends on imports of essential mineral raw materials more than any industrial nation of the world. Coal is the only mineral of outstanding importance of which it has supply adequate to meet the current requirements of its huge industrial setup. Except for petroleum, mercury, and antimony, the United Kingdom can obtain most of the mineral raw materials essential to the maintenance of its extensive iron and steel and nonferrous metal industries from its colonial possessions. The accompanying table on imports into the United Kingdom shows that Canada and Northern Rhodesia are the principal sources of Great Britain's copper, Canada and South Africa of asbestos and chrome ore, British Malaya of tin, British India of tungsten ore, and Southern Rhodesia of chrome ore. British Guiana is a potential source of supply of bauxite. Aside from preferential treatment in the tariff schedule of the United Kingdom applied to essential materials imported from colonial possessions and aside from the subsidies in one form or another granted the coal industry, for example, the mining industry is assisted by technical, statistical, and economic services provided by several agencies of the Government. The Department of Mines of the Board of Trade is probably the outstanding government organization that assists the mining industry. This department is charged with the administration of the mining law, the collection and publication (quarterly and annually) of mineral statistics, the study of the problems relating to mining practice, and the licensing of petroleum concessions.

The Geological Survey of Great Britain, which functions under the Department of Science and Research, conducts geologic research and prepares for publication maps and technical papers on the general aspects and economic phases of geology.

The Fuel Research Board of the Department of Scientific and Industrial Research was organized in 1917 to study the nature, preparation, and utilization of fuels of all kinds and to publish the results of such studies in technical papers.

Problems relating to smelting practice are studied and results thereof published by the Bureau of Metallurgy and Metallurgical Chemistry of the Department of Science and Industrial Research.

The Imperial Institute, created in 1887 in honor of Queen Victoria, was established to promote industrial utilization of the Empire's raw materials. The institute is equipped to deal with questions pertaining to sources, production, uses, and marketing of raw materials. It likewise maintains laboratories for testing raw materials to determine their uses and value. An outstanding product of the institute is the annual statistical summary of world production, imports and exports, entitled, "The Mineral Industry of the British Empire and Foreign Countries." For statistical research purposes, this annual volume represents a contribution that is not paralleled by any similar publication of other foreign government agencies.

IMPORT TRADE OF THE UNITED KINGDOM BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934[1]

Classified group	1932	1934	Classified group	1932	1934
Metals					
Aluminum (metric tons)			Other sorts except chrome, and pyrites...	1,794,638	4,382,616
Bauxite.....	123,883	163,760	Pig iron, including forge, foundry, acid, basic, smelted with charcoal, and vanadium-titanium (metric tons).....	137,200	127,673
Plates, sheets, bars, sections, tubes, wire, strand, etc....	1,487	3,290	Ferroalloys (metric tons)		
Oxide.....	1,828	25	Ferroalloys, including molybdenum, titanium, and vanadium....	5,168	10,267
Crude, ingots, blocks, billets, bars, etc.....	8,202	14,450	Spiegeleisen and ferroalloys of manganese, chrome, tungsten and silicon.....	12,934	27,272
Antimony (metric tons)			Iron and steel, scrap and waste, etc....	117,217	353,358
Ore, including crude antimony.....	863	1,096	Lead (metric tons)		
Regulus.....	3,226	5,162	Pig.....	226,047	317,836
Chrome ore (metric tons).....	22,012	37,140	Ore and concentrates.....	1,131	254
Copper (metric tons)			Sheets.....	3,780	3,031
Ore, including regulus, matte, precipitate, etc.....	33,702	41,993	Pipes.....	1,654	369
Unwrought, electrolytic..	92,649	112,034	Foil.....	17	(Not avail.)
Unwrought, including rough copper.....	56,836	142,936	Manganese ore (metric tons)...	79,833	205,560
Plates, sheets and strips....	3,135	3,790	Mercury, Quicksilver (kilograms).....	660,041	725,256
Rods and sections.....	15,736	23,420	Nickel (metric tons)		
Tubes, solid-drawn, of circular sections and other....	649	1,884	Pellets, cubes, etc., unwrought.....	750	3,921
Wire, in coils not circular, including uninsulated electric wire.....	1,069	1,011	Plates and sheets	79	16
Scrap and old metal.....	2,606	1,374	Ingots, sheets, strips, and uncovered wire..	808	1,265
Iron ore (metric tons)					
Manganiferous..	29,030	46,470			

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

IMPORT TRADE OF THE UNITED KINGDOM BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934.[1]—(*Continued*)

Classified group	1932	1934
Oxide	41	131
Platinum (kilograms)		
Grain, ingots, bars and powder	240.5	617.3
Other sorts, including alloys and manufactures n.e.s.	6.4	4.5
Tin (metric tons)		
Ore and concentrates	47,979	39,206
Blocks, ingots, bars and slabs	4,234	10,413
Soft solder	17	27
Foil	88	3
Tungsten (metric tons)		
Ore	4,183	6,641
Powder, wire, and other forms	3	3
Zinc (metric tons)		
Ore and concentrates	115,529	91,921
Crude, cakes, slabs, blocks, etc., and spelter	88,765	133,001
Rolled sheets, plates, and disks	13,476	18,165
Lithopone	6,130	12,872
Nonmetals		
Asbestos (metric tons)		
Raw and fibre	17,872	27,009
Waste, including asbestic	524	618
Barium minerals (metric tons)		
Barites, not ground	9,504	21,138
Barites ground	14,464	15,140
Blanc fixe	1,097	(Not avail.)
Barium compounds, binoxide-peroxide	2	.....
Barium compounds, other sorts, excluding barites and blanc fixe	1,303	1,558
China clay (metric tons)	297	450
Coal (metric tons)		
Coal	17,904	18,316
Manufactured fuel, briquets	199	1,421
Coke, gas and other sorts	10,377	25,595
Graphite (metric tons)		
Natural	9,164	11,802
Artificial	251	208
Crucibles	9	3
Gypsum (metric tons)		
Crude, unburnt, including alabaster	51,412	108,167
Burnt, calcined, including plaster of paris	3,766	10,145
Magnesite, crude, calcined, light and dead-burned (metric tons)	18,442	28,169
Mica (metric tons)		
Blocks, slabs, films, and splittings	1,327	1,741
Ground	333	718[2]
Nitrate of soda (metric tons)	11,318	16,358
Petroleum (barrels)		
Crude	10,529,000	13,700,000
Gasoline	27,747,000	32,168,000
Kerosene	6,192,000	6,328,000
Gas oil	2,775,000	3,728,000
Fuel oil	14,098,000	19,098,000
Lubricating oils	2,466,000	2,953,000

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

[2] Includes waste.

IMPORT TRADE OF THE UNITED KINGDOM BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934.[1]—(*Continued*)

Classified group	1932	1934
Petroleum spirits, other than motor	426,000	564,000
Other sorts	19,000	30,000
Fuel oil, bunkers	5,171,000	10,086,000
Lubricating greases (pounds)	1,287,000	(Not avail.)
Petrolatum (pounds)	10,443,000	(Not avail.)
Paraffin wax (pounds)	133,526,000	113,834,000
Asphalt and bitumen (metric tons)	120,507	86,945
Phosphates (metric tons)		
Lime and rock phosphate	358,525	429,833
Superphosphates	59,642	51,097
Basic slag	9,892	658
Potash salts (metric tons)		
Carbonate	2,917	3,570
Caustic and lyes	5,441	6,726
Chlorate	1,045	1,210
Chloride, muriate	37,666	47,315
Ferro- and ferricyanides, yellow and red prussiates	111	449
Iodide	14	6
Kainite and other fertilizer salts	69,460	90,545
Nitrate or saltpetre	5,862	6,209
Permanganate	311	(Not avail.)
Sulphate	23,517	36,625
Other sorts	185	548
Chromate and bichromate	99	103
Pyrites, iron, including cupreous (metric tons)	305,471	340,894
Sulphur (metric tons)	71,470	89,158
Talc, steatite and soapstone, ground and unground (metric tons)	15,115	19,277

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

PRODUCTION IN UNITED STATES OF 32 MAJOR INDUSTRIAL MINERALS
(In Metric Tons)

Commodities	1932	1933	1934	Per cent of total world[1]
Metals:				
Aluminum	47,600	38,600	33,600	19.7
Antimony[2]	304	426	293	1.3
Bauxite	97,895	156,651	160,371	12.1
Chromite	157	857	375	
Copper[3]	216,010	172,948	215,369	16.7
Iron ore	10,004,959	17,834,917	24,982,047	20.7
Pig iron	8,920,878	13,590,926	16,398,077	26.2
Lead[4]	265,775	247,367	260,753	19.5
Manganese[5]	18,062	19,453	26,940	1.0
Mercury (flasks)	12,622	9,669	15,445	23.0
Nickel[3]	177	114	142	
Platinum (troy oz.)				
Placer platinum	1,074	1,266	3,720	
From refineries:				
Platinum	1,694	1,050	1,062	
Other platinum metals	1,150	707	1,273	
Tin[3]				
Tungsten[6]	359	812	1,859	11.6
Vanadium[7]	245	2	9[8]	5.0
Zinc[4]	258,756	348,611	398,003	28.6
Nonmetals:				
Asbestos[9]	3,229	4,305	4,615	[13]
Barite	121,174	132,813	161,806	[13]
China clay[10]	312,972	373,062	386,763	[13]
Coal: Anthracite	45,228,000	44,943,000	51,862,000	29.6
Bituminous and lignite	280,963,000	302,663,000	326,011,000	
Fluorspar	22,907	66,161	77,823	[13]
Graphite	500[8]	500[8]	500[8]	
Gypsum	1,284,815	1,211,259	1,393,583	17.8
Magnesite	34,892	98,145	91,601	[13]
Mica[3]	6,540	8,104	7,267	[13]
Natural nitrates				
Petroleum, crude (bbl.)	785,159,000	905,656,000	908,065,000	59.6
Phosphate rock	1,734,300	2,530,282	2,880,017	[13]
Potash: Equivalent K_2O	56,236	130,070	130,944	6.0
Pyrites	192,748	288,874	439,466	[13]
Sulphur	904,732	1,428,630	1,444,288	[13]
Talc and soapstone	111,784[11]	148,840[12]	128,310[12]	[13]

[1] Calculated on basis of 1934 production; items representing less than one-half of 1 per cent not calculated.
[2] Approximate recoverable metal content of ore produced (80 per cent of reported content), exclusive of antimonial lead ores.
[3] Mine production in terms of metal content.
[4] Recoverable metal content.
[5] Continental (exclusive of fluxing ore).
[6] Concentrates containing 60 per cent WO_3.
[7] Metallic vanadium.
[8] Approximate production.
[9] Sold or used by producers.
[10] Sales of kaolin or china clay and paper clay.
[11] Figures represent sales of talc only.
[12] Figures represent total mine production of talc and soapstone.
[13] Not susceptible of calculation.

UNITED STATES

An analysis of the production table and comparison with similar statistics for the other major industrial countries of the world indicate that the United States is the largest producer of most of the minerals. Reference to the detailed import statistical tables and consideration of these data in conjunction with the production figures indicate that, with minor exceptions, the United States is also the largest consumer of industrial minerals.

The great mineral industries of the United States have been developed largely through individual initiative (National Resources Board Report, Dec. 1, 1934). However, government aid in the form of scientific, technical, and statistical services is provided to the mining industry by the Federal Government. The United States Geological Survey in the Department of the Interior, conducts fundamental studies in geology (including all mineral resources), makes inventories of mineral occurrences, estimates reserves, and develops geophysical methods of prospecting. The survey prepares topographic and geologic maps, studies surface and underground resources, and, through its Conservation Branch, has charge of the leasing of minerals on public lands. The United States Bureau of Mines, also in the Department of the Interior, is responsible for studies of methods of extraction and use of minerals, safety and health of miners, statistical information services, and research into the underlying problems of mineral economics. The National Bureau of Standards, Department of Commerce, is another Federal Government agency engaged in conducting scientific and technical research in physics, chemistry, and engineering. The investigations of this bureau relating to the utilization of materials, the processes and methods of fabrication, and the development of national standards frequently relate to commodities of mineral origin. The United States Bureau of the Census, also in the Department of Commerce, collects and disseminates mineral statistics, but these relate principally to products in an advanced stage of manufacture.

Although the United States now occupies a preeminent position as a producer and consumer of most of the major industrial minerals, there is evidence that domestic mineral resources are not unlimited. Despite the difficulty of estimating reserves, it is the consensus of opinion by geologists that the principal mineral regions of the United States have now been found and their general extent known; in many instances, their size is already measured. The geologic and geographic limitations upon further large developments are fairly definitely understood. It is now established beyond reasonable doubt that the United States is deficient in many industrial minerals, both in respect to present and future requirements; that for certain other minerals the domestic supply is limited to a decade or two; that, for building materials, only a few minerals such as coal and iron exist in quantities sufficient to supply domestic requirements for a century or more, and even these are to some extent limited with respect to higher-grade reserves. Of the 33 metal-mining districts that have yielded the greatest wealth to date, only 5 have been discovered since 1900, and none at all since 1907. The copper mines of Michigan, by far the deepest in the world, have gone a mile below the surface, and at such depths, despite the ablest of engineering, they are quite unable to compete with many low-cost districts elsewhere in the United States and abroad. In iron ore the incomparable Mesabi range, opened in 1893, has already yielded nearly half of its really high-grade ore, and the rest will hardly last another 40 years, although there are huge tonnages of low-grade ore. Depletion of lead and zinc deposits is far advanced, and despite large known reserves geologists are reluctant to forecast the source of supplies 20 years hence. It now appears that American oil reserves may not be the world's greatest; the extent of the Mid-Continent and southwestern deposits has not offset the depletion of reserves in many areas.

Although the United States is now and has been for some time the outstanding producer of many industrial minerals, signs are evident that first place in the production of certain key minerals so long held by this country, is being attained by other countries. Mineral exports are declining in relation to mineral imports. That mineral deposits are exhaustible and mineral commodities non-reproducible, that some minerals do not exist in the United States in quantities adequate for national welfare, that other

IMPORT TRADE OF THE UNITED STATES BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934[1]

Classified group	1932	1934	Classified group	1932	1934
Metals			Iron ore, including manganiferous ore, not elsewhere specified (metric tons)	591,767	1,450,433
Aluminum (metric tons)			Pig iron (metric tons)	132,727	116,325
Bauxite	208,920	169,328	Ferroalloys (metric tons)		
Metal, scrap and alloys, crude	3,658	8,333	Ferromanganese	18,766	23,723
Plates, sheets, bars, rods, circles, squares, etc.	54	100	Manganese silicon	335	79
Antimony (metric tons)			Manganese boron, manganese metal, and spiegeleisen not more than 1 per cent carbon.	(Not avail.)	2
Needle or liquated	394	378			
Regulus or metal	1,368	1,601			
Ore (gross weight)	3,337	7,670			
Ore (antimony content)	1,205	2,623	Ferrosilicon containing silicon 8 per cent and less than 60 per cent (gross weight)	877	6,642
Chrome ore (metric tons)					
Gross weight	90,574	195,383			
Oxide content	44,533	84,300			
Copper (metric tons)			(Silicon content)	317	999
Ore and concentrates for smelting, or refining and export (copper content)	2,911	10,151	Speigeleisen, less than 30 per cent manganese, more than 1 per cent carbon	8,498	21,575
Matte, regulus, black copper and cement copper for smelting, refining and export (copper content)	109	64,799	Alloys used in the manufacture of steel or iron, not specially provided for	595	462
Blister, for smelting, or refining and export (copper content)	21,112	90,164	Chrome or chromium metal	20	16
Ore and concentrates (copper content)	20,807	5,673	Ferrochrome or ferro-chromium, containing less than 3 per cent of carbon (gross weight)	162	112
Unrefined black, blister, and converter, in pigs or converter bars (copper content)	45,419	1,832	(Chromium content)	108	74
Refined, in ingots, plates, or bars	74,998	8,353	Chromium nickel	.....	1
Old and scrap	1,099	79	Chromium and sirconium silicon and calcium silicide	80	543
Rolls, sheets, tubes, rods, and wire	11	17	Ferrosirconium and sirconium ferrosilicon	.....	51

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

IMPORT TRADE OF THE UNITED STATES BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934.[1]—(*Continued*)

Classified group	1932	1934
Molybdenum ore and concentrates (gross weight).	(Not avail.)	167
(Molybdenum content).	(Not avail.)	97
Ferrophosphorus	722	34
Ferrotitanium	2	1
Tungsten metal, in lumps, grains or powder (tungsten content)	6	48
Lead (metric tons)		
Ore, concentrates and bullion for smelting, or refining and export (lead content)	19,574	5,049
Ores, flue dust, and mattes, not specially provided for (lead content)	87,516	9,761
Reclaimed scrap, dross and lead, not specially provided for, except antimonial (lead content)	31	258
Bullion or base bullion	2,335	2,014
Babbitt and type (lead content)	178	177
Pipes, sheets, shot, glaziers, and wire	492	259
Manganese ore (metric tons)		
Gross weight	92,138	346,814
Manganese content	45,060	168,500
Mercury, Quicksilver (pounds)	295,348	774,564
Nickel (metric tons)		
Ore and matte	2,684	5,373
Nickel and alloys in pigs, ingots, shot, cubes, grains, cathodes or similar forms	6,815	20,774
Bars, rods, plates, sheets, stripe, strands, castings, wire, tubes, tubing, and anodes, or electrodes	5	3
Oxide	312	431
Platinum (troy ounces)		
Ores of platinum metals (platinum content)	160	.....
Grain, nuggets, sponge, or scrap	25,440	119,469
Ingots, bars, sheets or plates not less than ⅛ in. thick	7,618	13,829
Metals and native combinations thereof	22,829	41,013
Tin (metric tons)		
Ore, cassiterite and black oxide of tin	17	2
Bars, blocks, pigs, grain, granulated or scrap, and alloys	35,378	40,628
Tungsten (metric tons)		
Ore for smelting, refining and export (tungsten content).	(Not avail.)	164
Ore and concentrates, etc. (Tungsten content)	42	384
Ore and concentrates, wolframite, scheelite, ferberite, hubnerite, stolsite, and raspite (gross weight)	76	712
Vanadium ore (metric tons)		
Gross weight	(Not avail.)	1,591
Vanadium content	(Not avail.)	335
Zinc (metric tons)		
Ore for smelting, refining, and export	7,272	3,794
Ores, except pyrites, not more than 3 per cent zinc	292	6,111
Blocks, pigs, or slabs	281	1,565
Sheets	35	50
Lithopone	4,285	3,563
Nonmetals		
Asbestos (metric tons)		
Unmanufactured, all chrysotile crudes	29,462	3,092
Unmanufactured, blue and amosite crudes.	(Not avail.)	157
Unmanufactured, spinning or textile fibre.	(Not avail.)	5,242
Shingle fibre	(Not avail.)	16,990
Paper fibre	(Not avail.)	15,833
Asbestos, not elsewhere specified, containing not over 15 per cent of foreign matter	58,312	67,851
Barium minerals (metric tons)		
Ore, crude	41,511	36,316
Ore, ground or manufactured	1,446	1,690
Barium compounds	823	773
Blanc fixe or precipitated barium sulphate	595	416
Crude, unground	2,431	2,139
China clay (metric tons)	90,543	91,422
Coal (metric tons)		
Anthracite	544,591	433,742
Bituminous	164,373[2]	104,545
Coke	106,207	145,998
Fluorspar (metric tons)	11,908	15,154
Graphite (metric tons)		
Natural amorphous	4,785	9,497
Artificial amorphous	5,953	525
Lump and chip crystalline	170	349
Dust crystalline	97	273
Flake crystalline	717	2,165
Gypsum (metric tons)		
Crude	339,354	326,757
Ground and calcined, or plaster of paris	2,949	1,469
Magnesite (metric tons)		
Crude	8	45
Caustic, calcined, lump	942	561
Caustic, calcined, ground	670	848
Dead-burned, grain and periclase	6,906	20,793
Mica (metric tons)		
Unmanufactured	1,250	3,192
Manufactured	97	296
Nitrate of soda (metric tons)	51,239	298,238
Petroleum (barrels)		
Crude	44,699,585	35,771,596
Gasoline, naptha, and other finished light products	8,381,481	135,311
Fuel oil, including topped petroleum	21,078,980	14,477,218
Illuminating oil, kerosene	78,257	8,316
Lubricating oil, including paraffin oil	18,563	7,364
Tops and other unfinished distillates	11,929	322,837

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

[2] Includes lignite.

IMPORT TRADE OF THE UNITED STATES BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934.[1]—(*Continued*)

IMPORT TRADE OF THE UNITED STATES BY COMMODITY AND CLASSIFIED GROUPS, 1932 AND 1934.[1]—(*Continued*)

Classified group	1932	1934	Classified group	1932	1934
Asphalt and bitumen (metric tons)	18,573	14,224	Sulphur (metric tons) Ore, not elsewhere specified		5,933
Paraffin and paraffin wax (pounds)	32,302,804	33,807,050	In any form	179	144
Phosphate rock, crude (metric tons)	6,477		Talc (metric tons) Crude and unground	147	185
Potash (metric tons)	300,235	441,041	Ground, washed, powdered or pulverised, except toilet preparations	7,897	18,265
Pyrites, natural state and spent oxide of iron containing more than 25 per cent of sulphur (metric tons)	257,313	372,194			

[1] Detailed figures covering countries of origin may be obtained from the Foreign Minerals Division, U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

minerals exist in surplus at the present time, that geographic distribution of minerals is fixed by nature and cannot be changed by government enactment and therefore domestic and foreign trade routes are pre-determined, are facts which, considered in relation to American production and consumption of minerals, constitute a public problem of conservation. This problem of conservation has been recognized by the federal and many state governments.

Although no comprehensive mineral policy has as yet been adopted by the United States, nevertheless the national and certain state governments are cognizant of the many economic problems involved, particularly that of conservation. In recent years, the tariffs, reciprocal trade agreements, commercial treaties, and certain measures of strictly domestic application, such as the emergency NIRA, have been negotiated or enacted with conservation of national resources in mind.

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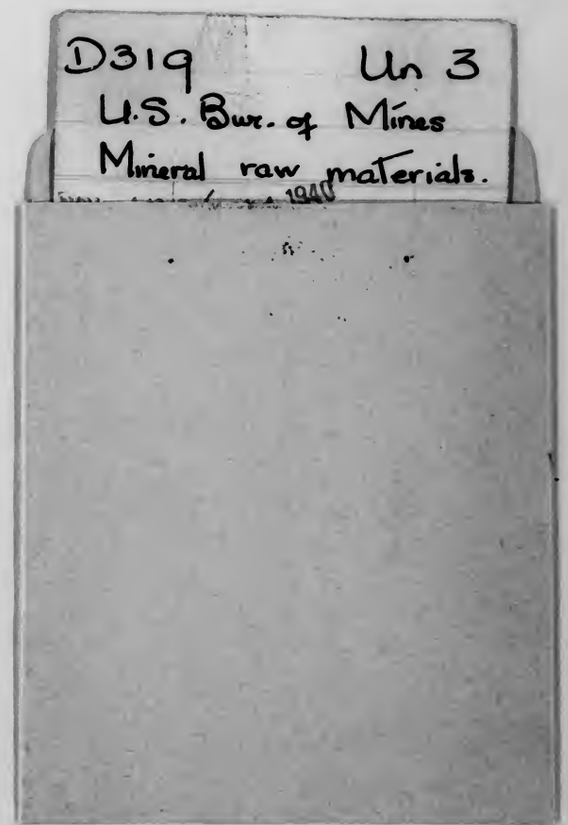

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